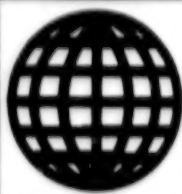


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## **Central Eurasia**

***Military Affairs  
Missiles Take Off From The Sea  
No 2, 1994***

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### Missiles Take Off From the Sea

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[FBIS Translated Text]

#### Annotation

This book describes creation of a new class of ships—strategic missile submarines, and it is devoted to the direct participants of these events. The author is a regular naval officer, and the operator of the missile launch team that carried out the world's first launching of a ballistic missile from a submarine.

#### Landmarks on the Fairway of a New Course

A scientific and technical conference devoted to events that occurred 35 years in the past, and marked the birth of the lead ship, the flagship of our navy's strategic submarine forces, was held in Leningrad on 1 February 1991.

On 16 September 1955, at 1732 in the White Sea, the world's first launching of an R-11FM ballistic missile occurred from the class V-611 submarine "B-67".

The safe launching of a guided ballistic missile from a moving platform—which is what a submarine is, and this missile's attainment of a coastal target hundreds of kilometers away in just minutes, confirmed the correctness of all of the basic technical concepts adopted during development, and demonstrated the promise of a new direction in missile and submarine building, and in submarine use. Consequently there are full grounds for treating this event as a revolutionary "landmark" designating the beginning of a new course in the navy's postwar development.

Speaking at the anniversary conference and assessing the importance of the pioneer effort that made this celebration possible, Academician S. N. Kovalev said that "it became the basis for creating a strategic submarine fleet; all of the technical concepts that were adopted and the ideology embodied within them remain fundamentally true even today, such that changes that did occur have been associated with technical improvements."

The experience of developing an absolutely new weapon and a ship to serve as its vehicle, the positive results of flight tests under an extensive program, and confidence in people able to not only create this equipment in a short time but also master it under naval conditions, permitted adoption of a decision without loss of momentum and continued movement on the new course with the goal of preparing industry to master series manufacture of the new combat equipment, and the navy to adopt it.

To attain this goal, plans were made to: test missiles for their reliability in the real conditions of day-to-day operation and combat use of submarines, including

transport tests on fueled missiles in submarine launch tubes, and tests on the missile system for blast resistance; designate the head missile enterprises specializing in naval equipment and to master series production of missiles and missile system components; begin construction of a series of five class AV-611 submarines developed on the basis of class V-611; prepare the Northern and Pacific fleets to provide basing for the missile submarines to be commissioned, and for their combat training and intended use.

The culminating event in this stage was the launching of series-manufactured missiles in 1958 from each of five finished missile submarines—early in the year in the Northern Fleet and in the fall in the Pacific Fleet.

Such was the course of events that "marked" the fairway representing the new course in our fleet's rearmament in the 1950s.

The work that was started in 1954 went far beyond the framework initially outlined by the government decree, and it was brought to its logical conclusion on a state scale by creation of the foundation, or the skeleton, of our country's naval nuclear missile shield. Now we could go on and pose the objective of strengthening it.

#### 'Blank' Pages of History

For obvious reasons, there were no reports, and all the more so, articles in the open press—nor could there have been—about the events that occurred in the 1950s associated with the birth of the new naval component service—strategic missile submarines.

In the beginning, all of the work proceeded under the stamp of "Top Secret, Special Importance." But later on, after 10 years, when this equipment was retired and replaced successively by two new missile systems armed with ballistic missiles, which were naturally improvements over the very first, it didn't seem to make sense to keep silent about the past anymore.

As a direct participant of those events—made so by the will of the naval commander-in-chief, I was able to publish two short essays: "The Very First" in 1965 in KRASNAYA ZVEZDA, and "On Ocean Orbit" in 1969 in Leningrad's SMENA. Given the limited possibilities of a newspaper article and the secrecy considerations that still had to be reckoned with, there wasn't much I could write about then. I was very stingy in my mentions of people, especially those who were still working and serving in this area. The leaders and chiefs were generally left unidentified. The censors even made me substitute the term "chief designer" by "missile designer;" this was absurd, because one person obviously can't design an entire missile—this is something that can be done only by many specialists of different profiles, by entire organizations.

This was apparently done out of the apprehension that the chief designer mentioned in the essay might be identified with the chief designer, as yet unnamed, who figured into messages from the Baykonur Cosmodrome.



What is most interesting—and the editors could hardly have been aware of this back then—was that the chief designer of space rocket systems and the chief designer of the first missile system to be carried by submarines was in fact one and the same person—Sergey Pavlovich Korolev. Such that he was also a pioneer in the area of naval missile building.

S. P. Korolev's first role became known to the country and the entire world only after his death in January 1966, from his obituary. But one could get an inkling of his "naval" activity only from the book "Tvorcheskoye naslediyе akademika Sergeya Pavlovicha Koroleva" [The Creative Legacy of Academician Sergey Pavlovich Korolev], published in 1980. However, the information it contains about this is so meager that it could be gleaned from the book only by very attentive reading. Thus, one could read on the pages pertaining to work done in 1956 that "...an operational-tactical missile armed with a nuclear warhead and a submarine missile were successfully tested and adopted for operation." There as well, in an account of scientific activity in 1955, USSR Academy of Sciences Corresponding Member S. P. Korolev writes:

"1. In the past year, 1955, two projects were successfully completed with positive results....

"4. ... An article concerned with naval issues was partially drafted...."

Paragraph 4 confirms that at least one of the projects mentioned in paragraph 1 was naval.

It was as yet impossible to make any conclusions regarding Korolev's importance to naval missile building from this brief passage, and all the more so to determine the volume of the work done and evaluate its significance.

Similar statements are made in an obituary on Academician N. N. Isanin in the 4 March 1990 edition of LENINGRADSKAYA PRAVDA: "The scientific and technical foundations of creating missile submarines were laid under his guidance in the 1950s. Submarines of which N. N. Isanin was the chief designer were the first to launch ballistic missiles."

One could probably already conclude from the cited information sources that if in the same period of time the first of the chief designers worked on ballistic missiles for submarines and the second designed missile submarines from which these missiles were launched, they had to have worked on this project together. And this is exactly how everything really was. But it was still impossible to associate, on the basis of available information, the names of these chief designers with particular models of the menacing naval weapons they were creating.

Nor is there anything about this joint pioneering effort of theirs in the museums of the head organizations that developed the missiles and the submarines. A few years ago I had the opportunity to visit S. P. Korolev's home, which is now a museum, established by his mother Mariya Nikolayevna Balanina and his daughter Natalya

Sergeyevna Koroleva. Among the numerous exhibits lovingly gathered by them, there is not a single one giving evidence of the naval side of Sergey Pavlovich's work.

How did it come about that this work, which was so important and so fundamental to the navy, and to the entire country as well, remain practically unknown?

I think that the main reason for this lies in the position Korolev took in this issue. After all tests on the missile and of the missile system in integration with the ship were successfully completed, and after the chief designer persuaded himself that the new project he had started was strong enough to stand on its own, he transferred the naval design work to another group headed by his student, Viktor Petrovich Makeyev. This is precisely why S. P. Korolev didn't emphasize his priority, conceding it to the young. This might also explain why the information contained in the published materials is so meager and so general.

My ideas regarding this do not disagree with the opinions stated by B. V. Raushenbakh, who had once served as Korolev's assistant: "Sergey Pavlovich was a person of unusually broad scope.... He generously shared his work with others. One could name several prominent designers who began their careers with him. Sergey Pavlovich was always unusually benevolent toward these people. After handing over one of his projects to them, he never under any circumstances made any mention of his part in them, even when major successes followed. On the contrary he was always repeating the word 'they, they,' and he continued to help them unobtrusively, sometimes even from a distance...."

I don't think that illuminating Korolev's role in creating the new weapons for the navy would somehow diminish the contributions of the group that accepted the baton from him, and subsequently created a number of submarine systems of even greater complexity and sophistication. More likely the reverse is true. This group could only take pride in acknowledging the roots from which it sprang, and the person it succeeded.

One could understand Korolev's generosity and Makeyev's reluctance to give up the gift of priority that was bestowed upon him. But what would that do for the history of submarine building, and for the history of the navy? By the way, circumstances were such that in the second half of the 1950s there occurred a transfer of command at all levels in the navy having a direct bearing on missile weapons. And as sometimes happens, history started over again, reckoning from zero. Neither Korolev and his group nor naval seamen who participated in the creation, testing and introduction of the weapons and of the first missile submarines in the navy were ever mentioned again. This in my opinion was one other reason why Korolev's part in naval projects fell into oblivion. Consequently both of the events associated with these projects were forgotten, and the names of the people who brought these events into being remained unknown. Several pages in the remarkable history of our navy having to do with the start of the scientific and

technical revolution in the navy, which was heralded by the act of arming submarines with ballistic missiles, remained blank.

In 1989 I made another attempt to publish materials illuminating the part played in these projects by Korolev and Isanin, as well as other chief designers and their collectives. But in vain. The essay that I sent this time to the journal OGONEK was misplaced, or so the editor's office told me. But a little while later its content was used in its entirety, and without any acknowledgement, in an article by a certain author I know, who for some reason appropriated for himself the right to be the "caretaker" of anything having to do with Korolev. This article was published in a certain academic periodical.

I could have said nothing, taking satisfaction in the fact that my goal had been attained: The role played by chief designers Korolev and Isanin in creating the first naval missile system and its submarine vehicle had been demonstrated. Still, the story was distorted with the goal, I think, of "wiping away the fingerprints," and what was most unpleasant was that it was dis-respectfully presented in a vaudeville genre, such that honorable people were portrayed as caricatures. The author obviously borrowed this farcical style from performances of the KVN [not further identified], in which he was a permanent member of the judging committee. I expounded my opinion of this article and of the plagiarism in a letter to him. But I came to understand from the reply that the addressee "had no shame."

This incident conclusively persuaded me that if the direct participants of the events do not write the story, hack writers who have connections with the publishing houses (this is important), and who could both distort the truth and hurt people just to make things "interesting," would surely surface.

The time has come—or to be more accurate, the time is already slipping away, when the past can and must be recollected by the direct participants of those events. This is something they can do because many years have passed since the time of the described events. The organizations led in their time by Korolev and Isanin haven't been working on submarine missiles for a long time, and therefore we won't be revealing any secrets—today all the more so, in our atmosphere of universal openness. But this is also something they must do because those who are still alive, and remember the past, have very little time left on this Earth. After all, the time clock of life relentlessly ticks off the years of the past, and with the passage of a little more time the mechanism may jam, and the clock will stop. And if we continue to place our hopes on someone else, it may turn out that there will be no one left who remembers anything. While we're still alive, we need to relate the events of distant years, and in this way pay our debt to the memory of those selfless enthusiasts who devoted the best years of their lives to establishing the new fleet. I'm certain that veterans will be capable of filling in the "blank" pages of history. By the way, their silence is one of the indirect reasons why these pages exist. Either they didn't want to

reveal their innermost secrets, or they were afraid to appear immodest in mentioning their participation in projects led by the famous chief designers Korolev and Isanin. But they do understand the value of these projects. N. V. Shaskolskiy—the chief of the launch team in the naval weapons test area in 1955, who was unable to attend the anniversary conference due to illness, wrote the following in a letter to the author: "I'm very sorry that I won't be able to make the trip, spend some time with all the people I remember, and reminisce about our intensive, purposeful life of those days, which apparently was ultimately useful to the fatherland, despite everything else."

I dare to begin this venture, and I very much count on the solidarity of those with whom I worked in those distant years, who labored with inspiration in that honorable and triumphant time. My faith in success is inspired by the example of publication of a remarkable book in 1987, "Akademik S. P. Korolev. Uchenyy. Inzhener. Chelovek. Tvorcheskii portret po vospominaniyam sovremennikov" [Academician S. P. Korolev. The Scientist. The Engineer. The Man. A Creative Portrait Based on Recollections of Contemporaries]. It was written by people who worked with Korolev or who came in contact with him one way or another in scientific, productive, social and even personal matters. There is not a single journalist among them, and in my opinion a book of this kind can only gain from this in truthfulness, sincerity, and in clear and comprehensive description of his personality. In it, everything is taken from life itself, and in it, you find personal impressions of the main character's complex and colorful personality on the backdrop of his characteristic working environment. In my estimation this is the best of all works ever about chief designer S. P. Korolev.

I've now decided to describe what I saw, knew, understood and felt in those days, and to share my thoughts about the past.

My recollections will be devoted to the birth of the missile weapons of submarines, but I think that history is interested not only and not so much in the events per se, as in the role played in them by specific people, their part in making this event come about, in their attitude toward the work, their thoughts, decisions, and acts, and finally, in manifestations of their humanity. It is about them, these great toilers, these heroes of the 1950s, that my story will be told.

They all deserve to be remembered, but unfortunately I am forced to limit myself to only those who will fit into my own story one way or another.

I very much hope that veterans who still value the importance of their work and who have something to say will respond to publication of these memories.

#### **'Whence That Which Is Sprung Forth...'**

The idea of arming submarines with guided ballistic missiles originated with naval seamen in about 1952.

The group that started it all included Engineer-Rear Admiral N. A. Sulimovskiy, Engineer-Captain 2d Rank

P. N. Maruta and Engineer-Captain 3d Rank N. P. Prokopenko. This group knew that before submitting a proposal to industry, they had to themselves think out the specific conditions under which the new weapons would be used in combat, and formulate the requirements corresponding to these conditions. But this wasn't enough either. They also had to work out the possible ways of realizing these requirements. The project was joined by B. V. Barsov, V. V. Sheremetev and D. P. Tkachenko, and subsequently by A. A. Bulygin, A. G. Vyzolmirskiy, A. S. Avdonin and other comrades.

The results of their work were the first precondition for raising the question before design organizations. The second, though in importance it might also be called the first, was finishing work on the design of the new R-11 army missile at OKB-1 [Special Design Office No 1] of NII-88 [Scientific Research Institute No 88]. This missile had a number of characteristics that met the requirements of missiles launched from submarines.

Armed with their studies and inspired by the advent of a particular model that could serve as a topic of discussion, the naval seamen turned to chief designer S. P. Korolev with a proposal, and asked him to agree to begin working on the naval project.

Assessing the initiative and resourcefulness displayed then by naval seamen in attaining their goal, we can say that figuratively speaking they prepared the beachhead from which a major offensive was subsequently started in all sectors of the problem at hand.

The idea of arming submarines with ballistic missiles was based on the following: Combining the fighting properties of these ships with weapons that were absolutely new to them would not only complement and broaden the combat possibilities of each, but also made it possible to create a totally new class of ships—missile submarines—able to carry out strategic missions heretofore uncharacteristic of submarines.

While in the past, the main mission of submarines armed with torpedoes was to deliver blows against enemy ships and vessels, and to do so they had to come within the range of direct visibility, now with ballistic missiles aboard a possibility arose for also hitting a ground target hundreds and thousands of kilometers away, and with a new missile weapon at that, one with striking power many times greater than previously possible with torpedoes.

In turn, a missile on a submarine acquired a mobile launch pad able to maneuver extensively in the horizontal and vertical planes, and characterized by high speeds, great endurance, and a huge radius of operations. All of this put together promoted covertness, and consequently, lower vulnerability of such a launch pad. The great range of the missile increased the area of possible deployment of missile submarines, which had to make fighting and detecting them more difficult. Chief designer Korolev did of course understand this idea, but he also understood the complexity of realizing it. After all, the conditions of combat use and day-to-day operation of ballistic missiles aboard submarines had nothing in common with conditions on land.

Without going into the details, let me simply single out a few of the problems providing an impression of the complexity of this task.

First of all room had to be found for missile launch tubes with a diameter of the same order as the diameter of the submarine's pressure hull, while at the same time preserving not only the traditional architectural shape but also the performance characteristics inherent to this class of ships.

Next, the missile had to be oriented on a target and launched from a rocking and moving platform. On land, after all, before it was launched a missile was set strictly vertical and oriented toward the target in the horizontal plane with geodetic precision.

Inasmuch as the time of a missile attack would be unknown beforehand in combat conditions, the missiles had to be kept constantly ready for launching throughout the entire time of independent navigation.

The missile had to be held reliably against the launch stand prior to launching, and then it had to be released the moment the engine was started up so as to preclude destruction of the submarine's telescopic devices and hull structures by the gas jet.

No less important was minimization of the time of prelaunch preparations. And obviously, of course, safety of personnel and the submarine had to be guaranteed during storage of a fueled missile in the launch tube in emergency situations and in combat conditions. It is evident even from this far from complete list of problems that the proposed project went beyond the framework of experimental design work.

However, our enthusiasts didn't come to the project empty-handed. Basing themselves on the preliminary studies, they proposed possible, realistic solutions to these problems.

In addition to the serious technical difficulties, there were obstacles of an ideological nature as well. First of all the military authorities had to be persuaded as to the suitability and possibility of creating a new type of naval armament, of introducing new means of utilizing submarines, and in this connection, of posing new missions. And as we know, new things aren't understood right away by all.

In the book "Vvedeniye v raketnuyu tekhniku" [Introduction to Rocket Engineering] published in 1956, its authors V. I. Fedosyev and G. B. Sinyarev were very cautious in their appraisal of the possibility of using ballistic missiles at sea: "A ballistic missile is a heavy, cumbersome apparatus requiring complex transporting and launching equipment. It would be hard to use such missiles on seagoing vessels as a consequence of this." This book was reviewed by a scientist well known in missile building, and a long associate of S. P. Korolev—Mikhail Klavdiovich Tikhonravov. Consider that the reference here was to seagoing vessels in general, and not to submarines, aboard which the conditions for using missiles should seem even more unacceptable.



If this was the opinion held by specialists whose knowledge of rocket engineering was based on more than just rumor, what could one expect from those who had no idea about it at all?

It is not surprising that skeptics were more than abundant during that time in the military environment. And the fact itself that this was the first time that "technical men" were promoting a strategic mission for the navy evoked a negative reaction at high levels. In short, they were in no hurry to turn on the "green light," and the "yellow" was only glowing dimly, attesting to the indifference of many to this new and unusual idea.

P. N. Maruta, who was then a group chief in the navy's Department 4, recalls that when he visited the top brass, he was often met with a lack of understanding. But being intelligent, forthright and independent, Pavel Nikitich boldly defended his idea to the top brass in both military and industrial departments. He was known for his convictions and his principles, he was respected, and he had access to organizations of these departments. He persistently continued to fight for O.K.'s and signatures for the documents he prepared with one goal in mind—to begin the work of arming submarines with ballistic missiles.

Engineer-Admiral Nikolay Vasilyevich Isachenkov, also a "technical man," who was naval deputy commander-in-chief for ship building and armament, played a noticeable role in the birth of this project. Admiral Lev Anatolyevich Vladimirovsky also provided all possible support. Both met with S. P. Korolev on several occasions.

It should be noted that P. N. Maruta did not sit idly by: He took a most active part in examining the technical issues with S. P. Korolev. In defending his opinion, sometimes he disagreed with him, and even argued with him.

The differences between them involved the possible means of launching. The military proposed an underwater launch with the engine started up in the launch tube. Korolev was afraid that owing to an abrupt rise in pressure and temperature in the launch tube, the missile might disintegrate, and fail to emerge. But P. N. Maruta felt that the process would proceed quickly, and it would not be dangerous, because not only gravity but also the pressure of gases formed in the space beneath the missile would act upon the missile.

An experiment was conducted at the OKB-1 without the participation of seamen: When the engine of a missile secured in a launch tube was started up, it caught fire. P. N. Maruta stated his opinion in this regard to Korolev directly and impartially, without mincing words, which was basically that an incorrectly designed experiment (with the missile secured inside the launch tube) couldn't lead to any other result.

Maruta's anger was quite understandable, because the negative results of this experiment could have cast doubt upon the idea itself of arming submarines with missiles—an idea that was just beginning to achieve recognition. Sergey Pavlovich was true to form in his reaction.

However, Pavel Nikitich, who was a fighter by nature and who was accustomed to receiving blows in the fight for the navy's interests, didn't flinch, and the conflict did not proceed any further. Korolev read Maruta's steadfastness correctly: His opponent's tenaciousness, particularly when he was in the right, was to his liking, and fit with his own style. Relations between them remained normal, without bad feelings.

It is interesting that P. N. Maruta continued to be a single-minded pioneer in the creation of new missile systems even 20 years into the future. It was no accident that Fleet Admiral of the Soviet Union S. G. Gorshkov, the commander-in-chief of the navy, suggested including him in the leadership of ground and ship trials with a ballistic missile that was totally unique in the means of its combat use. This time again, P. N. Maruta revealed his fighting nature, and completed the entire program of two stages of trials with positive and anticipated results.

Sergey Pavlovich could not be persuaded to agree to this work right away, at the first attempt. However, the interest expressed by military seamen and even, if you like, their obsession with the idea, apparently didn't play the last role in this either. These qualities, which were close and understandable to Sergey Pavlovich, had to raise his interest. But of course, most importantly there were the weighty technical arguments they presented.

Vyacheslav Pavlovich Arefyev, one of the pioneers of naval missile building and the general director of the NII KP [Scientific-Research Institute], reminisces: "One must give credit to N. A. Sulimovskiy's remarkable ability to competently and comprehensively present the particulars of using the weapons, and to methodically persuade representatives of industry and the navy at all levels in the realism of what was conceived. It was by watching him in action that I learned how to defend a position. I think that Sulimovskiy's insight and convictions were among the reasons why this 'world premiere' event was accomplished."

Gauging the promise of this new, naval direction in missile building with the gift of scientific prediction inherent to him, Sergey Pavlovich immersed himself in this work actively and aggressively. Now, many years later, it would be nice to know exactly what led Korolev to make such a decision.

There are no grounds for suggesting that the OKB-1 collective needed the work. I think that the order "portfolio" was full, if we consider that the world's first intercontinental missile was tested in summer 1957 and the world's first Earth satellite was launched in fall of the same year. Consequently it is absolutely obvious that in the 3 years prior to these events the design office was very busy, and the additional load of a naval project could be accepted only by "intensifying labor." Even while attending tests in the naval weapons test area Korolev continued to work on the satellite. Once when I visited the chief designer's private rail car, I saw star maps and a star globe there. Meaning that finding work for the collective should be discarded outright as a motive.

Then could it be that the novelty and complexity of the task piqued his interest? Without a doubt! As B. V. Raushenbakh recalled, Korolev very much enjoyed starting new projects. All the more so because a positive solution to this problem would mark the birth of a new branch of Soviet missile building, this time a naval branch, for which Korolev would be laying the foundation. Could one possibly remain indifferent to realizing such a possibility, and not provide the necessary assistance, not to mention personally participating in this?

Nor can we exclude the possibility that in the words of M. K. Tikhonravov, Korolev was "a person who was easily aroused and interested," that he was infected by a desire to solve this extremely difficult problem, one which appeared fantastic to many. But the future difficulties (Korolev was not one to be misled on this account) were justified by the promise of the new technology and its importance to strengthening the state's defense capabilities. And I think no one can doubt that Korolev was a man of the state, and a great patriot of his motherland, who confirmed these traits of his not in words but in daily back-breaking heroic labor.

There is one other circumstance which in my view motivated Korolev to consent to taking on the project. He had developed deep trust in naval seamen, so persuasively did they support his proposals. In their aggregate enthusiasm and a desire to penetrate deeply into the essence of the issue, the seemingly fantastic nature of the idea and presence of specific ways to make it a reality, and persistence and stubbornness in combination with clarity and accuracy, both in statement of the problem and in relations with industrial specialists, had to predispose Sergey Pavlovich toward the naval representatives. My certainty in the existence of this motive is supported by the fact that later on, his respect and liking for seamen, regardless of their official position, were to be manifested on several occasions.

Chief designer S. P. Korolev had become accustomed to working with his faithful associates—control system chief designer Nikolay Alekseyevich Pilyugin and propulsion unit chief designer Aleksey Mikhaylovich Isayev. It can now be asserted quite categorically that this was the first success in the new enterprise, and if I were to be more accurate, I would say that the seamen were simply lucky that the project fell to our best missile designers.

The next success was the consent of TsKB-16 [Central Design Office No 16] chief designer Nikolay Nikitich Isanin to design the submarine to serve as the vehicle for the ballistic missiles. Friends in the design office under his direction said that this work was offered to several chief designers, but apparently the absence of analogues made them doubt the possibility of carrying out such a project in limited time. TsKB-16 department chief V. I. Yefimov recalls that in late 1953 a meeting was held between N. N. Isanin and S. P. Korolev in his office at the OKB-1. Sergey Pavlovich showed the R-11 missile to his guest, and shared his thoughts. Understanding the complexity of the tasks posed to him, N. N. Isanin accepted Korolev's proposal. Such was the way this

remarkable union of two chiefs—S. P. Korolev and N. N. Isanin—was formed. Two or three days later Korolev organized an expanded conference, this time attended by N. N. Isanin, N. A. Pilyugin, Ye. G. Rudyak, N. A. Sulimovskiy, P. N. Maruta and representatives of the navy's Main Ship Building Directorate. Sergey Pavlovich brought up and discussed the problems of organizing coordination among the project participants.

The government decree "On Carrying Out Work to Investigate the Possibility of Launching Ballistic Missiles From Submarines and to Design the First Attack Submarines Armed With R-11FM Sea-Launched Ballistic Missiles" was published on 26 January 1954. The project was code-named "Volna" ["Wave"].

Leadership of work on this project was entrusted to TsKB-16 chief designer N. N. Isanin and OKB-1 NII-88 chief designer S. P. Korolev. The organizations participating in the work included the NII-885 (chief designer N. A. Pilyugin), OKB-2 (chief designer A. M. Isayev), NII-49 (director N. A. Charin), MNII-1 [not further identified] (director E. I. Eller), TsKB-34 (chief designer Ye. G. Rudyak) and Plant No 402 (director Ye. P. Yegorov).

In spring 1954, as that same V. I. Yefimov recalls, Korolev arrived in Leningrad. Isanin acquainted him with the results of the first efforts to accommodate the missile aboard a submarine. The leadership and leading specialists of TsKB-16 were convened in the conference hall for a meeting with Korolev. Especially memorable in Korolev's speech to the shipbuilders was his statement that "the components of the missile system (the launch tubes, the systems maintaining them, the fire control equipment) were so intimately connected with the structures and systems of the ship itself that our collectives had to work as one in fulfilling this unusual and very important assignment. Only in this way will it be possible to succeed in the enterprise it has begun. In this case constant attention must be turned to deadlines."

I would like to note that in the text of the decree, "creating the first combat submarines" is preceded by the work of "investigating the possibility of launching," from which it follows that at that time, there wasn't complete certainty of easy and fast attainment of the goal. Confidence began growing stronger quickly as subsequent events unfolded.

There is a maneuver in the naval Joint Sailing Rules referred to as "turn together." Such was the maneuver carried out by the organizations concerned with the decree when they turned "together" and raced toward the single goal. Everything proceeded simultaneously: The components of the missile system were designed and tested, the missile submarine was created, a rocking test bed was erected at the terrestrial test range in Kapustin Yar, and the newly organized naval missile test range was fitted out.

In terms of the breadth and pace of the work that was begun, the precision of interaction of the large number of collectives from different departments recruited for this work, and the efficiency with which coordinated

decisions were made, everything that happened then could be compared with preparations for a major military operation. All the more so because the role played in it by the military themselves was not a minor one. Personnel of troop units commanded by B. V. Lipatov, N. A. Sulimovskiy, M. A. Rudnitskiy, L. A. Korshunov, V. I. Voznyuk, I. A. Khvorostyanov, N. D. Sergeyev and V. P. Tsvetko took a direct part in the development and acceptance of plans, and in tests on the weapons and ships.

In order to reduce the time it took to complete all of the work, the commonly accepted sequence of development of a ship and its weapons was changed, and individual stages, even ones dependent upon one another, were carried out in parallel. Thus by as early as late 1954, long before flight tests on the R-11FM missile from the terrestrial test bed were started—that is, in the absence of expert confirmation of the possibility of launching this missile from a rocking platform, development of all of the planning documents for the missile submarine were completed, including the blueprints. Refitting of the submarine proceeded practically simultaneously with preparation for and conduct of tests of the missile from the terrestrial test bed. Flight tests of the missile with the submarines were limited to just the trials under the programs of mooring and drydock running tests of the ship. Only these two—the great chiefs S. P. Korolev and N. N. Isanin—could dare to do something like this. The responsibility was colossal. But ultimately by as early as August 1955, just a year and a half after publication of the government decree on the "Volna" project, both the ship and the missile system were ready for joint testing.

#### **The R-11FM—The First Sea-Launched Ballistic Missile**

The starting point from which realization of the idea of arming submarines with ballistic missiles began was, as was already said above, creation of the R-11 missile in S. P. Korolev's OKB-1.

I've been trying to find information about it in the open literature. There is clearly nothing in the TVORCHESKOYE NASLEDIYE. However, I was able to find among its illustrations a missile similar in appearance to the one with which we had to work. The missile's code name is not indicated, and the accompanying text was titled "Long-Term Storage Missile." A somewhat surprising name, but it did essentially have a bearing on the object of my search. After all, our sea-launched missile is also one intended for long-term storage. I read the text: "Creation of the first Soviet long-range ballistic missile stored and transported in fueled state occupied a special place in S. P. Korolev's activity... (the reference is to the 1950s.—A.Z.). The missile, which uses a displacement system to deliver the fuel components, and a propulsion unit designed by A. M. Isayev, became the progenitor of a new, specific direction in missile technology." The naval direction could also be referred to as a specific one, and consequently I continued my search. In the book "Academician S. P. Korolev. The Scientist. The Engineer. The Man" deputy chief designer Doctor of Technical Sciences Sergey Iosifovich Okhapkin (I

remember him: short, graying, very energetic, always preoccupied) writes: "Concurrently the system by which work in our design office was organized allowed us to develop the design of a long-term storage missile. These articles were also created within a short time, they successfully passed the full-scale tests, and then this type of missile was transferred to a specialized design office organized with the assistance of S. P. Korolev." Initially V. P. Makeyev's newly established design office was intended for series production of R-11 missiles. It appeared that my search was on the right track.

And finally, a confirmation by Doctor of Technical Sciences G. S. Vetrov in that same book, "Academician S. P. Korolev....": "Project No 2 foresaw development of long-term storage missiles.... Further work in this direction made it possible to outfit the navy with missiles." There can be no doubt that the illustration was that of the R-11 long-term storage missile, a prototype of the sea-launched R-11FM (both missiles are entirely identical in appearance).

The R-11 missile was designed under the direct leadership of Vasily Pavlovich Mishin, assistant chief designer at the OKB-1. The lead designer was Viktor Petrovich Makeyev. The control system was developed by the collective of the NII-885 under the direction of chief designer N. A. Pilyugin, and the propulsion unit was developed by the collective of the OKB-2 under the leadership of chief designer A. M. Isayev.

Two important identification features of this missile provided the grounds for viewing it as the prototype of a missile suited for use aboard submarines: first the new pair of fuel components, and second, its overall dimensions.

The R-11 missile used nitric acid as the oxidizer and tonka [translation unknown] or TG-02 (fuel developed by the GIPKh [State Institute of Applied Chemistry]—A.Z.). The pair used previously—liquid oxygen (an oxidizer with a low boiling point) and alcohol (the fuel) require continual drainage and refilling of the tank with volatile oxidizer from the moment the missile was fueled right up to the moment it was launched; consequently reserves of the oxidizer and special equipment were required. It was entirely obvious that this would be impossible to do in a submarine. Nitric acid, which is an oxidizer with a high boiling point, did not evaporate, and after the missile was fueled, it could remain combat ready for a long time without any additional operations associated with the propellant. Hence the name "long-term storage missile."

During modernization of the R-11 missile with the purpose of raising its fire and explosion safety in a submarine, the main fuel, TG-02, was substituted by kerosene, and TG-02 was retained in a very small volume only as a starting fuel that underwent self-ignition when it was combined with nitric acid.

The rapid attainment of full thrust by the engine of this missile, which was measured in seconds, dramatically



reduced the time of the gas jet's effect upon hull structures and telescopic devices (periscopes, radio and radar antennas etc.) of the ship.

Ending the discussion of the fuel, I should note that the fire and explosion safety of the "nitric acid—kerosene" pair was greater than that of the "liquid oxygen—alcohol" pair, and so the former pair was also preferred in relation to this parameter.

Compared to the R-1 missile (differing little from the German FAU-2), given similar values of their range and the weight of the warhead, the R-11 missile looked simply tiny. The launch weights of these missiles differed by almost a factor of three. "The developers," recalls V. P. Finogeyev, "fondly referred to the R-11 missile as the 'pencil'." In fact, this is the association that arises when it is compared with the R-1 missile: It is much thinner, the body diameter is the same along the entire length, and perhaps most characteristically the shape of the nose cone is reminiscent of a sharply pointed draftsman's pencil.

Comparison of the principal parameters of the geophysical modifications of the R-1 and R-11 missiles persuasively demonstrates the progress attained in Soviet missile building:

Characteristics	R-1	R-11
Length, m	15.0	10.0
Maximum diameter, m	1.66	0.88
Fin span, m	3.56	1.80
Launch weight, tonnes	14.0	5.0
Maximum vertical altitude, km	100.0	160.0
Payload, kg	65.0	71.5

The fuel employed and the overall dimensions of the R-11 missile made accommodating a ready inventory of missiles aboard a submarine, their safe storage, and maintenance of high combat readiness realistic. Still, however, the missile had to be launched and oriented toward the target in some way.

Using a weapon without surfacing is natural to a submarine. And of course, naval seamen lobbied for underwater launching, all the more so because the experience and information they possessed created a certain confidence in the possibility of such a thing. But the missilemen weren't so optimistic. Complete clarity was lacking in relation to a number of highly important problems that were new to them—ones like starting a missile engine in a launch tube, the missile's emergence from it and its encounter with the oncoming flow around the moving submarine (a submarine must be in motion during launching, since otherwise it would not be controllable), movement of the missile while under water, and others.

On N. A. Sulimovskiy's invitation Korolev visited the naval testing base in Leningrad, where he was given a demonstration of models of missiles launched out of a water-filled and drained launch tube. And although the

results of these experiments were positive, the chief designer knew that this was insufficient for a decision on this means of launching. There were no materials of a scientific, technical and experimental sort on this problem in missile building practice. And therefore reaching for the "highest prize" right from the start would have required lengthy scientific research, various experiments and field trials, and consequently, preparation of the corresponding logistical support. A special underwater test bed had to be created. A significant amount of time went to preparing for the tests and conducting them. In the 1970s I was given the opportunity to lead testing conducted with the purpose of perfecting underwater launching. And although this was already the fourth type of missile launched from beneath the water, the problems had not diminished in number, and the tests went slowly and with difficulty.

In those days, negative test results (their probability could not be excluded, given how much was known about the complex hydrodynamic processes accompanying an underwater launch) could lead not only to a longer development time, but also, considering the situation, to abandonment of the project as such. I think that this was precisely the kind of situation chief designer S. P. Korolev feared the most. And so he decided to launch missiles from a surfaced submarine.

As P. N. Maruta recalls, an idea suggested by N. A. Sulimovskiy was laid at the basis of this decision. It essentially entailed the following. Prelaunch preparation of the missile in the launch tube was to begin while the submarine was still beneath the water, after which the submarine would surface, the lid of the launch tube would be swung open, and the launch stand would be raised together with the missile to the upper end of the launch tube. It is from this position that the missile would be released. Then the launch stand would be lowered, the lid of the launch tube would be swung shut, and the submarine would submerge.

It all seemed simple. But as we know, nothing ever comes free. The sea, after all, is a natural phenomenon, and its surface may be disturbed, going as far as storm conditions. Waves will cause a submarine to rock, and the degree of rocking could attain sizable angles.

Considering the negligible occurrence of sea states above 5 points, we set this as the limit for weapon use. Under these conditions rolling of the submarine was anticipated for the tests within 12 degrees, and pitching was limited to 6 degrees.

Thus the conditions for surface launching of a missile were formulated: The submarine is in motion, it is yawing, and it is rocking in the transverse and longitudinal directions. Such that we went from the difficult conditions of an underwater launch to the no less complex conditions of a surface launch. Of course while the conditions of the former could only be hypothesized, those of the latter were fully known, which is what allowed us to begin working on the problem's solution.

Let me recall that when a missile is launched on land, prior to launching it is set strictly vertical and oriented to the



target by a pair of its fins (plane I-III). It was in this position that the onboard gyros, which impart stability and support the missile's flight in the active segment of the trajectory in accordance with the program, are set in motion.

But how was this to be achieved at sea? In principle, three ways of solving the problem existed theoretically. The first was to stabilize the ship, the second was to stabilize the launcher, and the third was to solve the problem using the control system of the missile system itself. The third way was the most realistic, and so the entire burden of modernizing the R-11 missile was laid upon the shoulders of the control specialists.

As I mentioned earlier, development of the control system was assigned to three organizations—NII-885, NII-49 and MNII-1. N. A. Pilyugin, the chief designer of the head institute, created a small group of young enthusiasts, to whom he entrusted the naval project. Twenty-six-year-old Vladilen Petrovich Finogeyev was put in charge of the group with the rights of an assistant chief designer. R. V. Maleyeva, N. V. Anikin, A. I. Kotlyarov, S. N. Galkina and other comrades toiled with him.

I met Vladilen Petrovich during the tests in 1955, we both participated in the tests in 1956, and then it was not until 35 years later that we met again, now in our sixties. Decades of our lives flew by like a single year. Our meeting occurred on the anniversary of our joint work.

Vladilen Petrovich devoted his entire life to missile design. He received recognition for his hard, productive work, and for attaining results of state importance—he served as a deputy minister.

He witnessed and experienced many things in his unusually intensive working life, he was able to maintain self-control in critical, stressful situations, and he remained as dynamic and concerned about events as he had been in his youth. Speaking at the conference and recalling his experiences, Vladilen Petrovich had to pause occasionally to contend with his welling emotions. And so while the speech he gave was concrete and laconic, it was also emotional. One could see that the work and the people who took part in it left a deep impression on his soul.

I remember him as young, tall and handsome, dignified in appearance, and easy to communicate with. On his own or with an assistant, he managed to get everything done without bustle. He took part in standard missile tests at the service area and launch site, and aboard the submarine. If suddenly some command would not go through or some equipment would fail, he would find the "bug" and correct it in a short time. He knew the system to perfection.

Vladilen Petrovich honorably represented his firm at conferences and in commissions. In 2 years of testing I never saw N. A. Pilyugin. V. P. Finogeyev enjoyed his complete trust.

Let's return to the problem of launching a missile from a rocking platform. A group of specialists from the NII-49 suggested a solution to the problem: Connect the missile

rigidly to the ship, such that its position would vary in space in space together with the submarine's. Set the position of the axes of onboard gyros, which communicate with instruments of the submarine's navigation system, when the missile is in prelaunch position. Given this orientation, the missile would leave the submarine at angles corresponding to the latter's position at the instant of separation from the launch stand. Then gas control vanes would adjust the missile to vertical position in response to signals from gyro sensors, and then all subsequent movement in the active segment would proceed according to the program embodied in the apparatus. Significantly modernized Girovertikant and Girogorizont gyroscopes were used as the gyros. A gyro-integrator of longitudinal accelerations operating with a synchronous gyroscope was proposed to control the flying distance. Developed earlier, this instrument successfully passed the entire complex of tests, including in the R-2 missile designed by the OKB-1.

The proposed means of initial orientation of the missile were realized by three collectives: onboard gyros—headed by chief designer V. P. Arefyev; ship computers (coordinate conversion)—headed by chief designer P. M. Zelentsov; submarine movement control instruments—headed by chief designer P. P. Koptayev. The overall director of the development project was chief designer V. F. Pechurin. Yu. A. Shcherbakov, V. L. Sokolov, M. Tsvetkov, A. Kuntsevich and other comrades took part in different stages of this work.

An encapsulated battery developed by N. S. Lidorenko was used for the first time in the missile. It maintenance-free, and it worked practically instantaneously. This was one other component of the missile that determined the degree of its combat readiness. Since then, the collective headed by Nikolay Stepanovich has attained enormous successes in creating power sources. The solar batteries installed in satellites and spacecraft are the fruits of its labor. I met Nikolay Stepanovich once, in 1962, on Kamchatka, during transportation tests on the missile next in line after the R-11FM. He left the most pleasant impressions as a very modest, communicative and sociable person.

In order to reduce the weight of the onboard apparatus and achieve faster acceleration of the gyro motors, the frequency was increased for the first time from 500 to 1,000 Hz, using a small rotary frequency changer developed by Andronik Gevondovich Iosifyan. Negative feedback from the turning angle of the gas control vanes was also used for the first time to automatically eliminate "zero drift" of the automatic stabilizer.

In general, as a result of introducing all of the innovations the R-11FM missile noticeably surpassed the R-11 missile in its possibilities, and in early spring 1955 flight tests were already under way.

#### Rocking Bed in Kapustin Yar

In May 1955 a group of naval seamen, testing specialists from the new naval weapons test range currently under development, and members of the crew of the submarine

"B-67" from the Northern Fleet arrived at the State Central Test Range in Kapustin Yar together with the submarine commander, F. I. Kozlov, for initial training.

I had occasion to visit here later on as well, and I always enjoyed coming to this place. This was a real oasis in the steppes: masonry houses, paved streets, sidewalks shaded by carefully tended trees and shrubs, cleanliness everywhere, few pedestrians during working hours, and everything you need for normal life. The civilized nature of the garrison was emphasized even more by the lack of roads and the dirt beyond it, the clay and wooden ramshackle houses, and the trash-filled yards.

All of this was evidence of the order that had existed and was strictly maintained back then, and of concern for everyday life—and ultimately, for people.

Credit for this doubtlessly belongs to the chief of the test range, Lieutenant-General (subsequently Colonel-General) Vasilii Ivanovich Voznyuk. His household was a hard one to maintain: It was dispersed over tens and hundreds of kilometers from the central square, but his eyes were able to see into all corners, his hands reached into all places, and in everything one could sense his soul, because without it, such a household could not be created or preserved. It was said that Vasilii Ivanovich once said, half-jokingly and half-seriously: "By the time we get through setting up the test range, the working and living conditions will be so good that only the luckiest will get assigned here, and then only by bribing their way." I don't rule out that this was so.

I should note the exceptionally benevolent and interested attitude displayed toward testing of naval missiles by officers of the State Central Test Range, and primarily its chief, General V. I. Voznyuk—a person who may be called, without exaggeration, legendary. I was able to meet him almost 20 years later, and his attitude toward naval projects remained unchanged. P. N. Maruta, who worked closely at that time with Voznyuk, said that in his youth, Voznyuk had dreamed of becoming a seaman (he was a native of Odessa). The unfulfilled dreams of his youth probably explain his attraction to the sea and his liking of seamen. And you'll have to agree that the latter is an important factor in any enterprise, especially a new one, when this kind of support is necessary.

We were accommodated in area 4a, which is where the service area and launch pad were located. We immediately found ourselves in a kind of unfamiliar world, straight out of H. G. Wells. Ballistic missiles would take off rather often, at any time of the day, from adjacent areas with a thundering roar. And each time we jumped up and ran out to see this spectacle, which was such a novelty to us (I doubt that you could ever grow complacent).

There was a unique test bed, the SM-49, at the launch site in our area, designed around a full-scale submarine launch tube. The launch tube could be rocked by special drives with an amplitude of up to 12 degrees, and vibrated within plus or minus 6 degrees about its longitudinal axis to simulate rolling and pitching of the submarine.

A launch stand that could be raised or lowered by means of a hoisting mechanism, and rotated on the launch tube's longitudinal axis, was installed within the tube.

A launcher was installed on the launch stand. It consisted of two retention posts topped by semicircular clamps. When the posts were drawn together the clamps formed a ring hugging the missile. Bosses on the missile body rested against thrust pads on the posts, such that the missile did not come in contact with the launcher. Prior to launching, the lid of the launch tube was swung open, and the launch stand was raised together with the missile to its upper position. The missile was held in place in the launcher, rocking together with the launch tube. When the propulsion unit was started up and the missile began to move, locks holding the semicircular clamps together were activated, an electric signal was transmitted from them to explosive bolts on the lower locks, and the retention posts were spread apart by a powerful spring. Released from the embrace of the launcher, the missile took off. After launching, the posts drew back together in response to a command from the console. The launch stand descended to its lower position, and the lid of the launch tube closed.

The diverging posts and the semicircular clamps sticking up from them made the launcher look like it had horns, which is why it was jokingly referred to as the "horns and hooves."

The rocking test bed made it possible not only to check the performance of all standard ship structures of the missile system, but also to recreate the dynamics of prelaunch preparations, and the conditions of launching from a submarine at a sea state of 5 points. It was designed by the joint efforts of the TsKB-16, TsKB-34 and OKB-1. At this point I would like to describe the critical situation that evolved during development of the launcher.

The TsKB-34 was made one of the organizations participating in the "Volna" project at the suggestion of N. A. Sulimovskiy, who worked for many years together with chief designer Ye. G. Rudyak on the design of naval artillery systems as a launcher developer. However, Ye. Rudyak, who couldn't agree to the deadlines suggested by Korolev, refused to work on the launcher. The TsKB-34 had a strong collective of designers, so I don't think it was that they couldn't do the job. It was more likely a personal thing: Rudyak was not used to collaborating, all the more so with Korolev, whose relations with him were strained. As P. N. Maruta recalls, their mutual enmity went as far as insults even at conferences held by GKOT [State Committee of the Council of Ministers for Defense Technology] chairman K. N. Rudnev. Rudyak refused to develop the launcher needed for the experiment, without considering that this would slow the whole project down. The TsKB-34's participation in the work led by S. P. Korolev and N. N. Isanin was limited to developing the drives that caused the test bed to roll and pitch, and even so, it used systems created earlier for stabilizing naval artillery mounts.

Given this situation, Korolev decided to have the OKB-1 develop the launcher. Pavel Vasilyevich Novozhilov recalls: "One of the characteristic features of Korolev's

leadership style was a fast work pace. The entire collective of scientists, designers, engineers and workers worked under his direction at this pace. When Korolev saw that certain collaborators weren't supporting the needed pace, he would take on certain jobs himself.

"As I remember, it was Spring 1954. It was morning, the start of the work day. I received an urgent summons from the chief designer. Our conversation was brief. In order that experiments could be conducted to reveal new possibilities of a missile launched in the conditions of a rolling sea, a launcher had to be developed and manufactured. When installed in the submarine, it had to hold the missile in place during rolling of the sea, and then release it at the moment of launching. All of the work had to be done in 6 months. This was a new assignment to us. We had no experience in anything like this.

"At first we didn't understand why Sergey Pavlovich agreed to develop and manufacture such equipment—after all, the OKB was already overburdened by difficult assignments. Then we found out that a collaborating organization (the reference here is to the TsKB-34.—A.Z.) refused to carry out the assignment due to the tight schedule. Such a schedule was dictated by the fact that all of the other physical parts of the experiment (the missile and the submarine) could be ready in 6 months. In order not to slacken the pace, Sergey Pavlovich decided to carry out this work in his own OKB.

"We employed an express planning method under which plant process engineers and associates of the supply department worked together with the designers. The manufacturing documents were prepared and deliveries of the needed metal and other materials were provided for simultaneously with drawing up the blueprints. Designers were organized into two shifts in the shops. This joint work by designers, process engineers, supply specialists and workers of the plant's shops made it possible to develop and manufacture the launcher, which demanded such a large labor investment, in record time."

The launchers were installed in place both on the rocking test bed and in the submarine on time, and they showed themselves to be dependable in operation, and easily maintained. And if Korolev had agreed with Rudyak at the time when the schedule was being set up, we would have had to wait a long time for the launchers, and the first of them would not have appeared in submarines of the next class, 629, until 1959. With such a long wait, there was no telling what the fate of the "Volna" project might have been—most likely it would have been scrapped. But chief designer Korolev was cognizant of the interests of the state, and he knew how to surmount barriers, going as far as even doing the work of others in the interests of the cause.

Thus Ye. G. Rudyak, who chose not to pull in the same harness with chief designers S. P. Korolev, N. N. Isanin, N. A. Pilyugin, A. M. Isayev and N. A. Charin, ignored the interests of the fleet.

Nor do I exclude the possibility that this incident was an expression of a conflict between fundamentally different

weapon systems: the old—classical artillery, and the new—missiles. And although the missions of the R-11FM missile system were of a totally different scale than those of ship artillery of even the highest caliber, Rudyak's opposition may have had subconscious causes—in any case, he didn't try to assist in the birth of the new weapon, which was an antipode to the old.

Besides the launcher itself, the OKB-1 developed the control equipment—the retention post spreading console. The entire development project was under the direction of Anatoliy Petrovich Abramov and Pavel Vasilyevich Novozhilov.

Completing the description of the launch site, I must say that its equipment outfit included launch preparation and launching equipment developed by the NII-885, and apparatus to orient the missile gyros in space and to input the initial firing data, developed by the NII-49. All of this was housed in an underground bunker in direct proximity to the test bed.

The tests were conducted by a state commission staffed by representatives from industrial organizations and the navy. Engineer-Captain 2d Rank N. P. Prokopenko was also on the commission. Technical leadership was provided to the testing by assistant chief designer Leonid Aleksandrovich Voskresenskiy, one of the pioneers of missile engineering, who shared with Sergey Pavlovich all of the difficulties of missile design, beginning with the first Soviet ICBM, and practically until the last year of Korolev's life (Voskresenskiy passed away a month before Sergey Pavlovich).

Here is how he is described by A. I. Ostashev, who worked dozens of years with him: "An extremely cool, decisive person able to take calculated risks. Tactful and attentive to people." Our countrymen saw him for the first time, without knowing yet who this was, in the documentary film "Ten Years of the Space Age." In it, standing at the periscope in the launch site bunker, Voskresenskiy gives the last commands to launch the missile carrying Yuriy Gagarin. Patience, confidence, and a readiness to act, immediately if necessary, could be sensed from the calm voice. The obituary stated that "A. A. Voskresenskiy always distinguished himself by untiring energy and great personal daring in carrying out important experiments." This was the kind of person to whom Korolev entrusted the job of supervising these unique tests.

The chief of the launch site, Engineer-Major Igor Aleksandrovich Zolotnikov, was a match for L. A. Voskresenskiy. Many at the test range told stories about the daring, life-threatening deeds of both of them. Back then, during preparations for the tests, they decided to see if the missile moved relative to the launch tube as the launch stand was raised while the test bed rocked. Securing themselves by firefighters' safety belts to the guard rail of the bridge at the upper end of the launch tube, they gave the command to activate the drives, and then to raise the launch stand together with the missile. With the two experimenters at the height of a five-story building, the launch tube began rocking, making full



swings. The launch stand was raised to its upper position. They saw that the retention posts didn't touch or hit the launch tube. There were no instructions that foresaw such an inspection. But both testers felt that it was needed. There was a risk, but the consequences of jarring the retention posts, which is something they feared, and their opening within the launch tube would be even more dangerous. However, everything ended safely.

The apprentice naval launch team was headed by the deputy chief of the ship testing department of the naval weapons test range, Engineer-Captain 3d Rank Nikolay Vladimirovich Shaskolskiy.

The paths traveled through life by Shaskolskiy and me crossed at the Higher Naval Engineering School imeni F. E. Dzerzhinskiy, and then at the Naval Academy of Shipbuilding and Armament imeni A. N. Krylov, but we didn't know each other well. Destiny brought us together in 1955 at the naval test range, when I was appointed to the testing department as the senior testing engineer. A technically competent, erudite officer, Nikolay Vladimirovich was perfectly fluent in German, and later on he also mastered English. He was distinguished by intelligence, high learning, and accuracy, but he didn't act like a know-it-all. He never raised his voice. He knew how to get his subordinates to carry out his instructions without pressure, and how to persuade his superiors that he was right. His arguments were always thoughtful and logical. He knew how to listen and agree with good suggestions, without insisting that his opinions should come first. He was a highly organized, very orderly person.

The first sea-launched missile was launched from a motionless vertically oriented launch tube. The launching was carried out by army missilemen, and we observed from the sidelines.

Flames flashed from the burning engine. The missile separated from the launch stand, and at the same instant the retention posts of the launcher spread apart. Gradually gathering speed, the freed missile raced upward looking like a candle burning upside-down. Soon after, it began tilting from the vertical in response to its program, and a short while later the engine cut off. The missile could no longer be seen—all that remained in the sky was the contrail marking its trajectory.

We waited impatiently in the field for the launch results. And finally (time passes very slowly for us in such instances) a message came to us that the missile was observed to fall where it was supposed to. We all felt joy—our sea-launched missile could fly.

Then launchings were carried out with the launch tube tilted, and during rocking of the test bed with the launch tube in different positions at the moment of the missile's separation from the launcher. The moment when the missile tilted dangerously owing to the lateral acceleration imparted to it by the rocking was an especially impressive spectacle, but right away the steering equipment countered the perturbation and set it on its programmed trajectory.

There were failed launches for different reasons as well—not many, just two out of 20. The fifth launching, which the naval launch team was allowed to carry out, was such a case.

The umbilical through which power was supplied to an explosive bolt had not been connected during preparation of the launcher. As a result, the moment the missile started up, one of the retention posts was slow in drawing back. As the missile ascended its fin brushed the post, and the missile became unstable and fell beside the test bed, some 50 meters from it. The ruptured fuel tanks caught fire, and the missile burned up despite active efforts by firefighters.

I stayed behind in the bunker for a while to reset the launch preparation and launching console, at which I sat as the missile operator.

Suddenly the telephone rang. The operator told me General Voznyuk was on the line.

"What happened?" Voznyuk asked. I briefly reported the situation.

"Anybody hurt?"

"No!"

"I'll be right there!"

When I left the bunker not more than 15 minutes after this conversation, the test range chief was already at the launch site. Considering the distance he had to drive from the nearest launching area, he must have been flying.

S. P. Korolev, V. P. Mishin and Ye. G. Rudyak flew in on the second or third day, followed by I. A. Khvorostyanov, N. A. Sulimovskiy, and other comrades. There were of course reprimands, and inquiries, but we weren't invited to them—I think to spare our feelings.

By chance while I was at the test bed I heard part of an exchange between S. P. Korolev and Ye. G. Rudyak.

"Why are you so bothered by this, Sergey Pavlovich?" Rudyak asked, in an effort to calm him down, or perhaps making light of the matter.

"Well, I am bothered!" Sergey Pavlovich replied abruptly, and even irritably—I think that along with me, he also sensed a kind of unfathomable optimism in Rudyak's tone regarding the situation, and an indifference toward the accident.

Korolev did in fact have a basis for concern. First, there weren't that many missiles yet, and they weren't cheap. Second, the cause of the accident was outright carelessness, which was something the chief couldn't tolerate. And third, perhaps most importantly, the missile could well have fallen on top of the test bed, and destroyed it. This would have stopped the tests for a long time, and perhaps forever. This would have been a perfect excuse for people who didn't believe in the project.

The person to blame for the accident, who suffered great anguish and begged that he be punished, but not barred from work at the launch site, was forgiven. He continued

to take part in the tests. He would never make such a mistake again, and you couldn't know what a new person might do. Sergey Pavlovich wasn't harsh in his relations with people, as I was able to persuade myself on several occasions.

Our first meeting with the chief designer occurred during this visit of his to the test range. We sat at the edge of the launch site in a smoking area. Sergey Pavlovich didn't smoke, but apparently upon noticing a naval uniform, which was unusual in these places, he came up to us. He greeted us cheerfully, and sat down. A conversation ensued. He asked who we were, where we were from, and perked up when he learned that there were members of a submarine crew among us. He kept a close watch on us, because naturally he couldn't remain indifferent to those into whose hands he had entrusted his offspring, and he did not conceal the fact. His gaze was steady, he spoke calmly, weightily, but confidentially and benevolently. And this is how he was in fact, although these qualities were concealed behind his stern exterior.

I realize now that this wasn't sternness—more likely it was concentration. Such concentration would be fully natural in a person shouldering the enormous burden of responsibility for an enterprise of priority state importance. He had several experimental design projects under his supervision simultaneously, and all of the work had to be done within the same time interval, which was extremely short at that.

Consequently the mission's success depended not only on resolving complex technical problems, but also on the level of organization of the work, on strict observance of the schedule. The Chief was necessarily beside himself whenever a deadline was missed, and he reacted accordingly.

During another launching the engine failed in flight. The missile strayed from the powered section of the trajectory and impacted 10 kilometers or so from the launch site.

Together with my comrades from the OKB-1—lead engineer K. D. Dorokhin and his assistant I. V. Popkov, I headed for the place where the missile should have come down. We drove over a totally featureless, sun-scorched steppe. Eagles were perched on posts holding up the telephone line connecting the phototheodolite stations. They seemed to sense that this was their turf, and they showed absolutely no reaction to our appearance. Mangled parts of missiles that had failed and strayed from their trajectories could be seen all over the place. It was a rather gloomy picture, a real wasteland.

Finally with the help of the operators of one of the stations who had seen the missile come down we found a crater of enormous dimensions formed by explosion of the missile's fuel tanks. Poisonous yellow smoke consisting of nitric acid vapors was still curling about the floor of the crater. We were unable to find anything that could help us to establish the cause of the propulsion unit's failure, but we were visually persuaded of the

destructive force contained in the missile, even one carrying just a telemetric nose cone.

Tests on the first sea-launched missile at the State Central Test Range caught the attention of the army's high command. Chief Marshal of Artillery Mitrofan Ivanovich Nedelin, the commander-in-chief of missile forces, visited during one of the launchings.

He appeared at the launch site in the morning, and descended into the bunker. We had been there since evening: The telemetric data from the general missile tests were not being recorded properly. Everyone looked tired, everyone was unshaven. It was raining, and consequently there were people taking shelter in the bunker who weren't part of the missile crew. The operator was sitting at the telemetric console in a poncho, because he had to keep getting up and going topside.

This was the situation that confronted the chief marshal. Not knowing what was happening, he angrily asked:

"Is this a gypsy camp, or are we supposed to be launching missiles here?"

However, upon hearing a report on the situation and realizing that everything was going along normally in the testing, and the people looked the way they did because they hadn't left the site for days, M. I. Nedelin relaxed. He began talking with F. I. Kozlov, who was also here at the moment. One detail has stayed with me—the gold watch on the chief marshal's wrist. I remembered this because after the disaster that occurred during preparations to launch one of chief designer M. K. Yangel's missiles at the Baykonur Test Range in 1960, which everyone knows about now, all that we could find of him was his watch. Yes, I would have to admit that missile flight tests have their dangerous side, as also does the tester's profession.

Apprenticeship at the test range was a serious learning experience for us. We learned that all kinds of things can happen during tests, from minor, easily correctable failures, to serious accidents. But you must never give up: On the contrary you have to seek the causes of failures, correct them, and move on. People created the equipment, and the equipment shaped the people.

We became acquainted with people at the top of their professions, people you could learn from, and use as an example, knowledgeable, driven, persistent people who were able to keep cool in all situations, and who were easy to communicate with. Among them I would include leading specialists like I. A. Zolotnikov, I. V. Popkov, P. V. Novozhilov, V. P. Finogeyev, V. P. Arefyev, P. M. Zelentsov and Yu. A. Sherbakov.

The program of flight tests on the R-11FM missile using the rocking test bed was completed. The results confirmed that a missile could be launched from a rocking platform, and that under certain rolling and pitching parameters the control system could support aimed fire at maximum angles and angular velocities.

On this basis the state commission concluded that we could now go on to the next stage of flight tests—launching the missiles from a submarine.

Naval seamen who took part in the tests also reached their objective: They mastered the new equipment, and learned how to carry out the entire complex of operations in the service area and launch sites concerned with preparing the missile and launching it.

Some of the developers are still amazed even today by how quickly we mastered the previously unknown technology. As for our success, I can say that it was brought about by sufficiently good theoretical training, and by our persistent desire to come to know this equipment well enough to control it independently a few months later in submarine tests, and to justify the trust with which we were honored.

And of course, another thing that was very important to us was that we, as novices to missiles, received recognition. A funny song to the tune of the "Sormovo Drinking Song" was even composed in celebration of our baptism as missilemen. Our names even made it into the refrain, in which they fit well with its rhythm:

"Shaskolskiy, Zapolskiy, Kozlov, Prokopenko, and with them all of the valiant Northern Fleet."

I'm especially grateful that fate arranged a meeting for me with Ivan Vasilyevich Popkov, the lead designer of OKB-1, who attended the tests. We met in the crater formed by explosion of the impacting missile. This acquaintance subsequently transformed into a friendship lasting many years. Communication in various situations with this remarkable person, a true friend, a fabulous specialist and a selfless patriot to the cause which he served, always imparted strength, and inspired.

#### Missile Test Range at Sea

The State Central Test Range had now been in existence for almost 10 years, and the first tests on the R-1 ballistic missile had been held there back in 1947. But the naval weapons test range had come into being only in legal terms, in a government decree on its creation, dated 1 November 1954. The newly organized range was to support flight tests of R-11FM missiles launched from a submarine.

What made the task difficult was that less than a year was left before testing was to begin, and test range's launch site had to be set up during this time on a marsh, in the tundra, on the unprepared coast of the Northern Marine Theater, all of its services had to be organized, the new equipment had to be studied and mastered, and not just the facility itself but also the testing resources, and the entire organization of flight testing had to be perfected in application to naval conditions. Because time was limited, all of these measures were to be carried out practically simultaneously.

A reconnaissance commission was organized by a directive from the Naval Main Staff in summer 1954 to select the region for missile test launches and for all of the range's launch sites. The membership of the commission included White Sea Naval Flotilla commander Vice-Admiral N. D. Sergeyev (the chairman), P. N. Maruta, V. I. Sorokin, A. G. Vyzolmirskiy, N. V. Shaskolskiy, V. V. Zenkevich, P. M. Makarenko, and other comrades. N. D.

Sergeyev allocated all of the needed transportation resources, both naval and air, and listened carefully to the opinions of the specialists. Despite the absence of any procedural directives, as a result of its energetic expeditionary explorations the commission selected and mapped the locations of the range's principal facilities: the service area and the administrative and barracks complex; the water area of the launch site, and the adjacent strip of coastline for installation of observation, measurement and communication resources; the missile impact zone, and stations supporting operation of its services. In its proposals the commission also accounted for the possibility of further development of the test range, which was to be used in subsequent years as well.

The well-organized, productive activity of the reconnaissance commission created pleasant memories for N. D. Sergeyev, and whenever he met P. N. Maruta later on, as the chief of Naval Main Staff and a full admiral, he always invited him over to talk missiles, to have his questions answered first-hand.

Now the selected sites of the test range had to be developed. This work was given over to its command and personnel. In order to have an idea of the volume of the concerns and the measure of responsibility of the command of such a unit, one must understand what a test range is. First of all there are the widely scattered sites and water areas (launch pads, missile impact zones, measuring stations) where the various technical resources and their service personnel are concentrated. Ships and aviation participate in the testing, and their coordination with ground resources must be organized appropriately. Because combat equipment is tested, accidents, disasters and even catastrophes are probable, and they have to be prepared for. There are the enormous amounts of facilities and personnel that have to be cared for. The personnel's work load is typified by an irregular schedule, under which forced inactivity alternates with feverish around-the-clock work. And in these conditions, unconditional fulfillment of the combat training plan and maintenance of the needed level of military discipline and technical knowledge must be ensured.

Testing is associated with technical disputes between industry and the navy, and with finding compromises, though of course not to the detriment of the enterprise. And finally, characteristically the high command, both naval and from defense industry organizations, and members of the government often swoop in on surprise visits. All of these circumstances were complicated to an even greater degree during the time when the test range was being developed jointly with direct preparations for specific tests. It was at such a time that manning of the test range was started.

Hero of the Soviet Union, Captain 2d Rank Ilya Alekseyevich Khvorostyanov was appointed chief of the first naval missile test range of this scale. Possessing a relatively low rank for his new admiral's slot, he treated people of different levels, from seamen and laborers to ministers and the Chairman of the Council of Ministers, the same—with honor but without superciliousness,



without groveling before high officials or assuming a fatherly attitude toward his subordinates. He always behaved evenly and calmly, he never went into rages. Because of this relationship to people, he enjoyed authority and respect both "from above" and "from below." The work assigned to Ilya Alekseyevich was new to him, he immersed himself in it and learned it, he heeded the points of view of others, and made the right decisions. In complex situations he didn't panic, he didn't chew people out, and he knew how to keep control of himself, but he was never aloof. He was a strict but just commander, and he commanded confidently, without bustle, without ambition. He took notice of and rewarded the labor of his personnel.

Khvorostyanov looked stern, but he actually had the kindest of souls. I can confirm by his example the known truth that a person's essence is determined by his smile and his laughter. Ilya Alekseyevich's smile was open and kind, and he laughed from the heart, infectious and loudly. It was easy to work under his command: Respect for oneself as a person and complete trust as a specialist could be felt. This pattern of command behavior naturally trickled down to all of the lower superiors, as a result of which an exceptionally favorable working situation evolved, to the benefit of the enterprise.

This is the sort of person that joined S. P. Korolev and N. N. Isanin in the leadership of flight tests of the R-11FM missile from a submarine. And I feel that this circumstance was also one of the components of the success of our saga.

Running ahead a little, let me say that Khvorostyanov retired from naval service with the rank of vice admiral, always remaining just as approachable and affable as I remember him from spring 1955.

They began erecting wooden panel buildings for our technical and maintenance facilities and barracks, on land wrested from the marshland by invading sand. Equipment of various sorts began arriving in the central area, where the service area and headquarters of the test range were to be located. Officers N. V. Shaskolskiy and V. M. Sharikov successfully handled their role as test range pioneers during this stage, displaying full independence (there was simply no one to turn to anyway).

The work of equipping the coastal part of the launch site and the missile impact zone, which was located in the tundra, began on a broad front in summer 1955. Delivering measuring, observation and communication resources and equipment to detect and fix the points of missile impact and, finally, all of the various everyday equipment and gear to this region involved considerable difficulties, often requiring something of the nature of landing operations, both sea and air. And the life of people in tents, in community with mosquitoes and biting flies, wasn't very appealing. Despite the optimism of the "Robinson Crusoes," the romanticism of life here fell far short of the prose of day-to-day life. There was even a fire once, but it was quickly put out.

Mention should be made of the enormous amount of work done under the direction of the chiefs of the leading

subunits of the test range—Fedor Petrovich Sorokin, Vladimir Petrovich Yefremov, Yevgeniy Yefremovich Shurmelev, Vladimir Sergeyevich Vissarionov and Petr Mikhaylovich Zhuravskiy, officers subordinated to them—V. D. Shurubovich, V. Starchenkov, Ye. A. Bykov, B. A. Zolotyakov and A. I. Suslin, the brothers Yan and Vladislav Pyshkin, E. A. Denisenko, V. S. Koshelev, V. I. Lebedev, and many other worthy comrades.

I don't think I'd be making a mistake comparing the naval weapons test range with the State Central Test Range in miniature, only with the addition of the sea, together with all of the complexities it entails.

#### The Missile Submarine

We returned to our test range by mid-August. Our comrades also wasted no time, and Lieutenant Eduard Aleksandrovich Denisenko, the chief of the search party, had already reported his readiness to observe and fix the points of missile impact, even from the most remote areas of the missile impact zone.

Prior to becoming a missileman I served as a mechanical engineer aboard submarines, and naturally the first thing I wanted to do upon my arrival was to see our missile submarine.

Standing by the wall, the class V-611 submarine "B-67" differed little from an ordinary submarine—in any case the difference wasn't obvious. The only obvious difference was the higher and longer conning tower enclosure, which also embraced two missile launch tubes emerging from the pressure hull. Their diameter was such that several people could stand simultaneously at their bottom without crowding each other.

Despite its impressive size, the missile submarine had an elegant appearance, and the sloping cut of the back of the conning tower enclosure imparted the sensation of speed. Such was my external impression of the ship.

Going below and into compartment IV, I now could see that this was a missile submarine, and everything in it was different. The launch tubes were installed in the diametric plane in the bow section. The instruments and devices were arranged on two decks. Among them were two systems with the beautiful names Saturn and Dolomit. These were the combined directional gyro and artificial horizon, and the computer connected to it and the missile's onboard gyros. And in the missile compartment, a total of six action stations. Cramped, but on the other hand the entire missile system was visible at a glance. Everything was right there: the apparatus, the people, the missiles in their launch tubes, and the ocean beyond.

All of the planning documents having to do with the rebirth of this ship as a missile carrier were drawn up by the TsKB-16. The detail design was developed on the basis of the preliminary specifications drawn up in the Naval Institute of which Engineer-Vice Admiral Leonid Alekseyevich Korshunov was the chief. These preliminary specifications were preceded by sketches made by officers B. F. Vasilyev, V. V. Bashenkov, N. I. Petelin



and K. B. Malinin (the son of the well known submarine designer B. M. Malinin), and engineer N. N. Grigoryev. Officers of N. A. Sulimovskiy's institute took an active part in this: P. N. Morozov, N. P. Prokopenko, V. N. Sheremetyev and B. V. Barsov. By the way, all of the listed comrades were mechanical engineers aboard submarines prior to acquisition of their new missile specialty, owing to which total mutual understanding reigned between the submariners and missilemen.

Several approaches to creating a missile submarine that could launch ballistic missiles were examined: building a special floating platform, building a new submarine intended solely to test missiles with the purpose of studying the possibilities for launching them, and refitting a submarine already in the inventory in one of the classes with the largest displacements. The last approach appeared the most preferable, because it allowed solution of problems of testing the missile system in minimum time. The suggestion was to refit one of the series-manufactured postwar large class 611 torpedo submarines.

The second important question to which an answer had to be found was how to accommodate the missiles aboard the ship. Several means were studied, to include: horizontal positioning of high-strength launch tubes containing the missiles on the upper deck or along the sides of the ship, in which case the launch tubes would have to be deployed to vertical position prior to missile launch; vertical positioning of high-strength launch tubes along the sides of the submarine's pressure hull, and vertical positioning of the launch tubes behind the conning tower, cutting through the pressure hull in the ship's diametric plane.

V. V. Bashakov recalls: "In spring 1954 the institute was visited by chief designer S. P. Korolev to examine the preliminary plans for the missile submarine. Simple in manners, he attentively listened to the explanations of the authors of the plans, made his comments; he didn't appear to us as strict and severe as some comrades described him. During the conference Sergey Pavlovich expounded a number of fundamental considerations regarding the particular way in which the missiles and their system components were to be located, and how the missiles were to be stored, serviced, and launched from the ship. As a result of the exchange of opinions the conference participants decided upon the approach of refitting a large class 611 submarine, with two vertical launch tubes cutting through the pressure hull in the diametric plane behind the conning tower." After their approval by the naval commander-in-chief, the preliminary specifications developed on the basis of this approach were adopted by TsKB-16 chief designer N. N. Isanin as his plan of action.

Boris Konstantinovich Razletov, the former chief engineer of the design office directed by Nikolay Nikitich, describes the philosophy and the breadth of the design thought and activity of N. N. Isanin: "Isanin worked on cruisers, heavy cruisers, and battleships, and during the war, on torpedo boats. Later on, beginning in the 1950s, he worked on submarines, primarily missile carriers."

Even from the meager information contained in his obituary one could imagine and assess his role in creating missile submarines. I must say that this was the role of a pioneer, and not only in creation of new ships but also in the birth of new missile systems, because flight tests of the new missiles were carried out with these ships. Consequently all of the technical concepts adopted in the development of the complex system consisting of a submarine and a missile system were checked out in these tests, after which they were introduced into ships of other classes armed with the new missile system.

The uniqueness of N. N. Isanin may be illustrated by a story recalled by G. A. Matveyev, former chief of the Central Scientific Research Institute imeni A. N. Krylov: "In 1964 I had the opportunity to visit the Ansaldo firm in Italy. They remembered there that there was a certain young person among the apprentices who came there in 1937 to study the experience of cruiser construction. They had some difficulty recalling his name, and it was only after some consultation among themselves that they arrived at 'Isanin.' There was something about Nikolay Nikitich that caught their attention, considering that they could still remember him almost 30 years later." And that time, the apprentice was only 33 years old.

Nikolay Nikitich was a slender, handsome man. His black hair, sharp nose and dark complexion imparted to him a certain similarity to Nehru. He was active and energetic, and he had a sense of humor. It is said that when he was elected to the academy, as he received congratulations from USSR Academy of Sciences president A. P. Aleksandrov, Nikolay Nikitich asked:

"And so what am I supposed to do now?"

"Oh, nothing, just come here when its time and get your money, and that's all!" Anatoliy Petrovich replied, playing along with him.

Nikolay Nikitich came back with: "Do I have to? I've already got so much money I don't know what to do with it!"

The detail design was ready by September 1954, and the contractor design was ready by the end of the year. And in the next year and a half a class 611 submarine was refitted as a class V-611 missile submarine ("V" is the first letter of the word "Volna" ["Wave"]). It is difficult to imagine today how they were able to not only draw up all of the planning documents but also refit such a submarine, and fundamentally at that, in such a short time. This was a real act of labor heroism by the collective of Ship Building Plant No 402, headed by its director Yevgeniy Pavlovich Yegorov. The activity of this person, who devoted his whole life to military ship building, is an inspiring example of faithfulness to a chosen path of life.

Having begun in 1933 when still quite young at the ship building plant in Nikolayev as the senior builder of the prototype of a miniature submarine, the M-1, Ye. P. Yegorov was in charge at the time described here of one of the sector's largest enterprises. He led the collective of many thousands competently, strictly, and thoughtfully.

He was hard-boiled by nature, and would not tolerate shortcomings. He was feared, although he was never observed to display any kind of petty tyranny. What was astounding was that during working hours, people could rarely be seen outside the shops throughout the enormous territory of the plant through which the local bus passed—all were at their work stations. Order was strict, and the results of the labor collective, which had to work in the difficult conditions of the North in behalf of the country's defense, were impressive. The last time I got to see Yevgeniy Pavlovich was in 1967. He was still just as active, efficient and demanding. He behaved simply, without any kind of pompousness, despite the scale of the production operation and the high assessment the government made of his personal contribution to the enterprise's success.

Such was the person who found himself in the same harness with S. P. Korolev and N. N. Isanin in the 1950s. And of course, this circumstance also went a long way to ensure efficient solution of all of the problems that arose. Yegorov's closest assistant in designing the lead missile submarine was senior ship builder I. S. Bakhtin, a knowledgeable, omnipresent and untiring war veteran. Despite the inflexibility he displayed in his work, Innokenti Stepanovich remains in my memory as a cheerful, kind person.

In the beginning, members of the state commission chaired by N. N. Isanin convened regularly. S. P. Korolev was appointed to act as his deputy and the technical testing supervisor. Referring to this order of subordination, Sergey Pavlovich, who had made friends with Nikolay Nikitich, joked: "I'm just the head—he's the headest of us all!" Test range chief I. A. Khvorostyanov was another deputy chairman.

These persons supervised the testing. While there naturally were differences in the characters of each of them, they were all typified by independence, boldness in making decisions, and demandingness, coupled simultaneously with trust and kindness toward people. All of these qualities predetermined the creative mood of the entire collective, and helped to support the work pace set by chief designer S. P. Korolev back at the very beginning. The fate of the new direction of naval armament depended on the results of the complex and dangerous experiment prepared for by this collective.

To work out the organization of the forthcoming missile launchings and the ship maneuvers in the vicinity of the launch site, and to complete certain inspections under the program of shop performance trials of the ship, a trial trip was planned for the submarine.

On its eve, N. N. Isanin held a meeting of the state commission. After reports were given on the progress of preparations for flight tests, launch team chief N. V. Shaskolskiy acquainted the commission members and persons invited to the meeting with the planning table for coordination of all services, manpower and equipment of the test range and the duty stations of the submarine for the test launch. The very important and, in addition, well prepared document was perceived by

everyone as the scenario of a film with an exciting plot and a happy ending, and it evoked lively optimism among those present. I remember how V. P. Finogeyev, who reacted to everything quickly, suggested thanking Shaskolskiy on the spot. Nikolay Nikitich calmed everyone down, saying "there'll be time enough later for all that." He was right, but unfortunately, this "later" didn't come up even to this day.

The test range launch team and representatives of all organizations that developed the missile system participating in the launch test according to the operational bill were to go out to sea.

Because the trial trip was planned for 10 days, Korolev decided to return to Moscow for this period. But he definitely wanted to be there to see the submarine off. I can't remember why, but the departure planned for the morning was postponed a few hours. Because the industrial members of the launch team hadn't yet been put on the submarine's messing list, some of them went to a nearby dining hall for lunch.

It was getting close to the departure time, the entire crew was already aboard, and so was the launch team from the test range. It was at this time that Korolev appeared. Submarine commander F. I. Kozlov reported to him that "the submarine is ready for departure, we're only waiting for your comrades." He was barely able to finish his sentence when the lunch group appeared with I. V. Popkov in the lead. Several of the blue stripes on his tee-shirt were visible beneath his unbuttoned shirt collar, and a naval cap with a crab emblem was perched on his head. If they were late, it was only by a few minutes. The row that ensued! All of the Chief's anger came down upon the leader, while the "followers" took this opportunity to quickly scurry aboard the submarine.

"What would you say if I booted you out of here, and didn't let you ship out with us?!" Korolev burst forth with rage.

"You can take the train back to Moscow, for all I care!"

I, and probably all who were present at this moment, didn't attach any special importance to the threats of the angry Chief, so no one felt any fear, but angering our beloved and respected patron, and see him so unsettled, was an unpleasant experience.

A command was given: "Take your stations, cast off!" The berthing parties busied themselves, and the ladder was retracted. Seeing that the submarine was about to drift away from the wall, a sorrowful, resigned Ivan Vasilyevich asked Korolev for permission to return to the test range.

"What, are you still here? Get aboard!" the Chief ordered, though it was evident that the built-up "steam" had already bled down.

Taking a running start, a "forgiven" and joyful I. V. Popkov leaped from the wall to the deck of the submarine and sped toward the conning tower.

Korolev knew how to control himself, to remain composed, and he could keep his cool, especially in acute, extreme situations. But sometimes he blew up over trivial things, without any serious causes that could at all justify his sudden explosions. By the way, later on, after I came to know Sergey Pavlovich better, I believe that he raised this ruckus mainly as a teaching tool—to maintain military order among everyone.

The trial trip proceeded normally. The plan of measures was fulfilled. On returning from sea, when in the base area, we conducted Operation Emergency Jettison. For this, a weighted mock-up of a missile with positive buoyancy was loaded into the launch tube prior to going out to sea. The mock-up was raised to the upper end of the launch tube, and the submarine was made to list by filling the ballast tanks on one side. In response to a command from the console to retract the retention posts, the jettisoning mechanism was activated. It raised the mock-up, the posts holding the device spread apart, and the mock-up flew overboard. I mention this to emphasize that everything that could happen in the tests was foreseen. Subsequent events showed that this test was a useful one.

The dress rehearsal had ended. The missile submarine was ready for testing of its main ammunition.

#### **A Ballistic Missile Is Launched From the Sea**

The long-awaited moment finally arrived. The missile was loaded into the launch tube, and general tests were conducted. The departure for sea was set for the morning of the following day, 16 September.

But no matter how great the desire was to carry out the launch, the technical supervisor cancelled the trip. The sea was calm, and he wanted the launching to occur from a disturbed sea. This was in chief designer S. P. Korolev's style: not to simplify an experiment, but on the contrary to bring its conditions as close to real as possible, and not hurrying unnecessarily, just for appearances. However, toward noon the wind picked up, whitecaps appeared on the sea, and the decision was made to set out for the launch test. The crew was already aboard, the launch team and the participants of the launch test from industry went below. S. P. Korolev and N. N. Isanin were accompanying us out to sea. Those remaining ashore wished us success, agitated and downright envious of their comrades entrusted with the first launching of a missile from a submarine. The tug turned the submarine about, and then the latter sailed away from the base. After a while the submarine submerged to check its trim—a mandatory operation when setting out to sea.

Everyone involved in servicing the missile system was in the missile compartment. All of the developers of the individual systems were here—V. P. Finogeyev, V. P. Arefyev, Yu. A. Shcherbakov, V. Ya. Sokolov, P. M. Zelentsov, P. V. Novozhilov, I. V. Popkov, Ya. S. Knobler, and others. Launch team operators Yu. A. Batayev, A. G. Yushkov and K. M. Abrosimov were at their stations. My place was at the missile preparation and launching console. It had all of the switches and buttons except the main one—the "Launch" button.

This button was installed in the submarine's control room, and it was to be pressed by V. P. Finogeyev: His was to be the last action in launching the missile. N. V. Shaskolskiy was in charge of the launch team.

This was the first time people were to be so close to a missile as it lifted off. Their backs rested against the launch tube, and by opening a manhole on it, they could easily touch the missile with their hands. Neither a safe distance, nor the protective concrete walls of a bunker, nor any shelters were present here. This was another unique feature of the missile weapons of submarines and the work of their crews. While we all appeared calm, we were of course actually excited, and hopeful that the launching would be successful.

Sergey Pavlovich appeared in the compartment, seated himself sailor-style on a folding chair, and silently drifted into his own world. Today I understand why: He was observing the custom of sitting down before a long journey, before its most difficult and critical leg, during which irreversible processes were to begin. His arrival was deliberate—by his presence he wanted to discharge the situation and release the tension. At the same time, however, we could not allow his silence to lower our guard. The people relaxed, their confidence grew, and consequently the probability of incorrect actions and mistakes decreased.

Many years later, after Korolev's sudden and absurd death, I read that in his youth, Sergey Pavlovich participated in the filming of "The Tripolye Tragedy" as an extra. I had seen this film very long ago, and of course I've forgotten the story, but I still remember the part where Zelenyy's band was crowding the Reds toward the bank of the Dnepr, making short work of them. It was then, as it turns out, that Korolev leaped from the steep Tripolye slope into the water, in order to "earn a little money for books and for English varnish for his glider."

Who knows, perhaps while in the compartment of the submarine as it submerged to check its trim, he remembered how he himself dove into the Dnepr's waters upon leaping from the precipice. What other "dives" and "surfacing" had this unbending person experienced in his life?

Just as we were approaching the test area the submarine was unexpectedly overtaken by a launch carrying naval deputy commander-in-chief Admiral L. A. Vladimirovskiy. Being truly concerned for the fate of the fleet, he couldn't remain indifferent to the forthcoming event, and preferred to be with those who were creating and testing the new weapon.

The submarine neared the starting point for the pre-launch maneuvers, and assumed its attack course. The prelaunch preparations began 1 hour prior to launch. The first operation, which was an extremely critical one—filling the missile's spherical tank with compressed air—was carried out by lead designer I. V. Popkov and senior engineer Ya. S. Knobler, the developer of the ship's pneumatic system. At 30 minutes prior to launch the alarm signal sounded through the submarine's compartments, and the voice of submarine commander F. I.



Kozlov came over the loudspeakers: "General quarters!" Gunnery department commander S. F. Bondin gave the command to turn the launch stand to the firing angle.

Sergey Pavlovich ascended to the conning tower in order to supervise the launch from there. Such direct participation in the launch test was not at all required of the chief designer, but S. P. Korolev himself determined his place and functions.

Beside him were F. I. Kozlov and L. A. Vladimirskiy. N. N. Isanin and V. P. Finogeyev were in the control room.

The launch team donned its headphones and established communication among themselves and with "Number One." This was the call sign of the testing technical supervisor, S. P. Korolev. Orders from "Number One" could be heard through the headphones.

Sergey Pavlovich gave his orders sharply, in military fashion. His voice was a little muffled, and his pronunciation of the letter "g" was soft. I noticed this back in our first meetings, but back then I wasn't able to figure out why he spoke like this. It was not until later, after publication of Sergey Pavlovich's biography, that I learned that he spent his childhood and young adult life in Ukraine.

The final minutes were ticking off. Power to the missile was turned on. The gyroscopic instruments were started up. The initial firing data were transmitted to the missile. Light signals went on to show that onboard and ship instrument control systems were working in harmony: The missile was oriented on the target.

The submarine neared the launch point. Sergey Pavlovich commanded:

"Five minutes to launch!"

The rack-and-pinion opened, and the lid of the launch tube lifted up. The launch stand and missile rose to their upper position. The missile was above the submarine, and it rocked together with it.

"One minute to launch!"

"Roger, one minute," was the reply from all stations in the missile compartment.

"Ready! Launch!"

The "Launch" button was pushed.

I watched the signal lights as the process went on, and I relayed their interpretation aloud:

"We have DU start-up!" (DU is short for propulsion unit), followed by:

"Lift-off!"

The missile broke away from the launch stand. This happened at 1732 on 16 September 1955.

Remembering the way thunder penetrated into the underground concrete bunker a rather large distance from the launch pad whenever missile took off, now in the submarine, in the missile compartment right next to the launch tube, everyone expected to hear something

similar. We operators weren't too concerned about this, because we were wearing headphones that we borrowed earlier from the boat crew. Still, some of those present decided to plug their ears with cotton just in case: God cares for the careful. However, the predictions and apprehensions were not confirmed. To everyone's surprise we did not hear noise of any intensity, and moreover, it stopped abruptly. The explanation to this phenomenon followed later: The sound disappeared as soon as the gas jet from the engine nozzle stopped impinging upon the submarine.

This "sound" reminds me of a story. A year later Northern Fleet commander Admiral Andrey Trofimovich Chabanenko attended one of the launch tests. We were on our way from the base to the launch area. The admiral and chief designer were talking in the commander's cabin. I approached them to report our readiness to Sergey Pavlovich, and overheard the commander saying:

"..., yeah, they told me it sounds like someone banging pots!"

A look of bewilderment appeared on Sergey Pavlovich's face: What was music to his ears—the sound of a starting missile—was given such a prosaic comparison.

It was transmitted from the ship accompanying us that the missile's launch and flight had been normal, and soon after, the missile's impact was observed in the missile impact zone. This was the visible birth of something new. A ballistic missile had been launched from a submarine for the first time. The missile attained a target several hundred kilometers away in just a few minutes.

After the first launch the tests continued in accordance with the program.

Not long before setting out to sea for the first launch test, in preparing for such a noteworthy event the submarine crew repainted all of the pipelines in colors corresponding to their purpose. This initiative had its consequences. As naval deputy commander-in-chief Admiral L. A. Vladimirskiy went topside after returning from launch tests at sea, he got paint on his raincoat. In his gracious way, Sergey Pavlovich tried to rectify the situation using the back of his dark blue gabardine raincoat, but he wasn't entirely successful. The Chief reached the proper conclusion from the incident. Taking account of naval traditions, he departed on the second trip in well-tailored khaki overalls with bunches of lightning bolts on the pockets. Naturally the overalls didn't go unnoticed. On seeing the delight in the eyes of operator Yu. A. Batayev in this new acquisition, Korolev promised on the spot:

"After we finish the testing, I'll give it to you!"

Despite being extremely busy, Sergey Pavlovich went out with us for each launch test at sea, and supervised all missile launchings. I think that he did this not because he didn't trust us, but in order to assume direct leadership in a critical situation, should one arise, and to take full responsibility for its outcome. And such cases did occur.

Thus, during prelaunch preparations of the fifth missile, after the "Launch" button was already pressed and the missile's tanks were charged, the launching was automatically cancelled. The faulty missile remained perched on the launcher stand. V. P. Finogeyev shares his impressions of the incident. "An extremely dangerous situation came into being: A fueled missile was rocking above the submarine, what was wrong with it was unknown, and what to do next was unknown. It could of course be dumped overboard straight away. But how could this be done without first trying to analyze the cause of the failure and utilizing all of the possibilities for starting up such an expensive missile? And so Sergey Pavlovich made an extremely risky decision—to go topside and inspect the missile, because he suspected the failure was caused by a bad connection in the umbilical between the missile's onboard control system and the ship equipment. I was summoned to the bridge, and the three of us—Sergey Pavlovich, Fedor Ivanovich and I—made our way over to the missile and inspected everything we could. We discovered nothing out of the ordinary. And although everyone knew how important it was to establish the true cause of the failure so as to exclude its probability in the future, the chief designer ordered:

" 'Emergency jettison!'

"Imperturbable Anatoliy Yushkov, the operator at the retention post release console, carried out this order.

"The missile was then jettisoned."

This was not an easy choice to make, but upon weighing all of the pros and cons, the Chief made the only correct decision, the one that would guarantee the safety of the people and the entire ship.

Later on, Captain-Lieutenant Vadim Konstantinovich Korobov, the submarine's executive officer, told me his story: After the missile was jettisoned he ascended to the bridge, which was then occupied by technical supervisor S. P. Korolev, submarine commander F. I. Kozlov, and V. P. Finogeyev. Turning to Korolev, Korobov noted:

"Sergey Pavlovich, you gave the order so calmly, as if jettisoning missiles was second nature to you!"

"What do you mean 'calmly'? The back of my shirt is soaked with sweat!" Korolev replied.

The second unforeseen incident also occurred during pre-launch preparations. This time the pointer on a voltmeter showed that the missile had been powered up prematurely, before the command to start up the onboard battery was given. This meant that the battery was already on. But when? How long had it been in this state? No one could answer this question, and consequently guarantee that when a load was applied to the battery, the voltage wouldn't fall below normal and a failure wouldn't occur during flight. N. V. Shaskolskiy reported the situation to Sergey Pavlovich. Korolev cancelled the launch test, and we returned to base. The missile had to be unloaded in order to replace the battery. The chief was very displeased (another loss of time), and gave orders to create a commission to clarify the cause of the incident. I was appointed chairman of this commission.

There was one means of starting up the battery—feeding compressed air into it. The pneumatic system had been developed by a very competent specialist who fussed a great deal over every little detail. He checked out this system the day before the submarine left for sea. It was hard to believe that he may have erred, and blown air into the wrong line, but the fact was clearly there to be seen, and miracles don't happen.

Several days passed while the commission studied the possibilities, and wrote out and typed the certificate. During this time the battery in the missile was replaced, and a successful launching was conducted. The issue lost its acuity. The commission's conclusions were rather uncertain because it was unable to establish a clear cause. There was not a single word in the document regarding who might be to blame.

I appeared in Sergey Pavlovich's private rail car with this document. It was a sunny day, and it was bright and cozy in the car. A few division chiefs and lead specialists from the design office were sitting there. Everyone was in a good mood. Sergey Pavlovich was wearing a silk shirt and no tie, as if he were at home. I reported that I had brought the commission's certificate for approval. Korolev took the certificate and sat down at his desk. Upon reading it, Sergey Pavlovich turned to me:

"How did the commission come up with such a non-party document?"

"Sergey Pavlovich, what do you mean by 'non-party'?"

"You haven't named the person at fault, and I wanted to punish him!"

By his tone and his use of the past tense for the word "wanted," I realized that his anger had passed.

"But we couldn't establish that he was at fault, and he is an outstanding specialist!"

"All right, I'll approve it!" Korolev answered, and signed the certificate.

I was once again persuaded of his kindness toward people.

Having traveled through such brier patches in his odyssey, he didn't grow hard and calloused.

Or here's another incident that occurred during tests in 1956.

The submarine was on its attack course. It was less than 15 minutes to launch, the initial firing data had already been transmitted, and the gyros were responding to the commands transmitted from the fire control instruments.

Suddenly one of the industrial representatives, who was first to notice the characteristic odor of insulation burning in a transformer, rushed to the combined directional gyro and artificial horizon to discover that the gyro platform had fallen askew. Consequently the onboard gyros were not oriented, which could cause the missile to fall after it was launched. I immediately

reported this to Sergey Pavlovich in the conning tower. After talking it over with the submarine commander he made his decision:

"Everything back to normal operation, we're returning to base!"

It was around 1400. I remember the time because I have often recalled this case as an example of the Chief's ability to act effectively.

We returned to base at full speed. We had to hurry because the day was coming to an end, and it was Saturday at that.

Sergey Pavlovich quickly went ashore and got in contact with the organization that developed the failed system. A replacement transformer had to be delivered without delay. Despite the fact that it was the end of the work day, and of the week, the transformer was delivered the next morning at 5 o'clock by a special airplane. We carried out two missile launchings on Sunday, 31 October, once again at around 1400. It took just a day to deliver a transformer from another city a thousand kilometers away, install it, check out the system, and carry out the launching. This was an example of excellent organization of testing for all to follow, and an indication of Sergey Pavlovich's enormous authority.

Now, many years later, I tend to think that there was also an emotional factor in Sergey Pavlovich's choice of his site for launching missiles from a submarine. What do I base my hypothesis on? First, what aircraft chief designer hasn't dreamed of launching the product of his work into the air himself? It was precisely here that chief designer S. P. Korolev had such an opportunity. Second, the entire situation reigning aboard a submarine, where tight discipline and order existed side by side with the relative freedom of the personnel, and where orders were carried out sharply and quickly, though without bustle, made an impression upon this highly organized person. Supervising the launching directly from the command post, he probably felt himself to be a member of the ship's crew. And that was essentially the way things were. The chief designer was listed on the ship's bill, you see, as the launching supervisor—that is, he was a member of the ship's combat crew when it came to firing missiles.

Here is one confirmation of my hypothesis. A superior is commonly addressed aboard submarines not by rank but by position: "Comrade Commander!", "Comrade Executive Officer!", "Comrade Brigade Commander!" and so on. Consequently during testing at sea, when we were carrying out operations as the moment of launching approached, I addressed Sergey Pavlovich in similar fashion: "Comrade Chief Designer!"

Later on, I think in 1958, I visited S. P. Korolev at the OKB-1. He received me right away even though State Committee for Defense Engineering chairman K. N. Rudnev was in his office at the time. It was evident that my unexpected appearance awakened the feelings that Sergey Pavlovich has experienced in the submarine's conning tower, and so he introduced me like this: "Meet Comrade Chief Gunner!"

We didn't have such a position either on the standard table or the ship's bill, but during the last tests in 1956 I was the chief of the launch team. That's why he said what he did.

By the end of October 1955 all of the tasks foreseen by the testing program had been carried out. In a month and a half, or one might say within the blink of an eye, seven missile launchings were carried out. The tests confirmed the possibilities of launching an aimed fire of missiles from a submarine, the safety of the weapon to the ship and its personnel, and capable operation of all missile systems together with ship systems.

The high pace and the results of the tests were due exclusively to their efficient organization, coordinated interaction among all test range services and the submarine crew, high dependability of the equipment to be tested and the supporting equipment, and of course, the full investment of effort by all participants of the tests.

The swiftness of the tests and their positive results had a decisive significance to confirmation of the prospects of the new direction in naval armament, and of the need for developing this direction further.

#### On Ocean Orbit

A missile submarine may be compared with a giant two-stage rocket in which the first stage—the launch vehicle—is the ship itself, and the second is the rocket per se. Starting off from its mooring, the launch vehicle inserts itself into ocean orbit, from which the missile may be launched at any moment.

During the flight tests we did not go far out to sea, just as far as the launch site, and therefore the time the fueled missile remained in the launch tube did not exceed a day or two. In a real situation this time would increase to the time of the submarine's independent navigation.

In the environment, vibrations from working mechanisms, rocking, concussions by shock waves, and many other factors to which a ship is subjected at sea impinge upon a missile in a submarine launch tube. Under these conditions the missile must maintain its flight characteristics and be safe to the personnel and the entire ship. Transport tests were planned in order to check these qualities out. This was to be the first long cruise by the submarine with fueled missiles in its launch tubes.

The participants of the tests were given the task of subjecting the missiles to the maximum impact of factors associated with navigation, to carry out the necessary observations and measurements, and after keeping the missiles in the launch tubes for a prescribed time, launching them. The complexity of the forthcoming experiment lay not only in the absence of experience in carrying it out, but also in the statement of the task itself: On one hand, we had to check out the missiles in the most difficult, extreme conditions, while on the other hand we could not allow an emergency situation to arise. We understood quite clearly what could happen in an accident.

There was also something else that we had to keep in mind. At that time, not everyone believed yet in this new



naval weapon, which was just undergoing its birth, and any distortion of the testing results could postpone or delay its introduction. Therefore mistakes or hasty conclusions were impermissible. This was a factor associated with something else—the knowledge and experience of the cruise participants, their sense of responsibility.

Supervision of the testing at sea was assigned to a group from the state commission, which consisted of technical testing supervisor I. V. Popkov, submarine commander Captain 3d Rank I. I. Gulyayev, who had replaced F. I. Kozlov, and me, now the chief of the launch team. None of the support personnel that are usually included were there.

The trust that was placed in us was very great. We were very young, after all, with the "oldest" of us being the 30-year-old submarine commander. Long before the testing began, Northern Fleet commander Admiral A. T. Chabanenko said to Gulyayev: "You'll be the first to go on a distant cruise with missiles aboard. The equipment is new to you, and little is still known about it. We've seen the enormous combat possibilities of the missiles, and now we have to persuade ourselves as to their dependability. So keep the testing conditions rigorous, and don't spare the equipment!"

Commission assistant chairman I. V. Popkov had just turned twenty-seven. S. P. Korolev had already taken notice of, and singled out from among many, this short but well-built, sociable Volga native for his wisdom and brightness, the selflessness of his work, and his ability to find a common language with people and to motivate them.

Drawing up all of the necessary documents for this cruise—ones such as the testing and measurement programs, the cruise route and organization, and measures to prevent and recover from accidents—was assigned to the future participants of the tests themselves—officers from the naval test range, the submarine, and from one of the naval institutes.

A. A. Zuykov, I. I. Gulyayev, V. K. Korobov, I. A. Balashov, I. V. Mayorov and the author participated in drawing up the documents.

S. P. Korolev and N. N. Isanin came over to monitor the preparations for the tests. We reported our ideas about the organization of the testing in the office of the chairman of the state commission—I. A. Khvorostyanov served in this capacity in this phase. We pointed out the routes of the forthcoming cruises on naval charts posted on the walls. Sergey Pavlovich did not conceal his satisfaction in the meticulous preparations for tests to be conducted for the first time. He was very organized and composed by nature, he was an excellent writer, and he obviously valued the clarity and brevity of the documents. He suggested that they be approved.

Several days before the start of the cruise naval commander-in-chief Admiral S. G. Gorshkov convened a conference. The directors of the sectors to which the organizations developing the weapon and the submarine were subordinated, the chief designers, and military chiefs of a high rank were present. Ye. P. Yegorov, I. A. Khvorostyanov and I. I. Gulyayev were among the participants.

After Gulyayev's report that everything was in readiness for the cruise, S. P. Korolev spoke. Because the crew wanted the best possible support to the cruise, he stipulated that he wanted to be delivered to the submarine without delay, no matter where it was, should the need arise, considering that this was the first time the tests were to be conducted, and that they were dangerous. The chief designer was promised such a possibility.

It was foreseen that the submarine would be accompanied by a trawler under the command of Captain-Lieutenant G. A. Ammon. Chemists were accommodated aboard the trawler with a field laboratory in order to analyze the air environment in the launch tubes with the purpose of preventing accidents; the trawler also carried medical personnel that could render aid to the personnel, should such a need arise.

On the day after this conference Sergey Pavlovich invited the three Northerners to his office in the OKB—Ye. P. Yegorov, I. A. Khvorostyanov and I. I. Gulyayev. Upon acquainting his guests with the work plans of his collective in general terms, Korolev returned to the transport tests, emphasizing the importance of meticulously preparing the ship itself, its crew, and the missiles for them at the test range. I think that he wanted to learn at this meeting what the mood of the executives was, and their attitude toward the forthcoming critical phase of the work, and to assist them as necessary.

We made ready to head out into the Arctic.

Autumn with its cold winds and stormy seas was at the doorstep. Living conditions aboard a diesel submarine are known to be far from comfortable, and to be honest, they are downright hard. Especially when the submarine is running on the surface, and air sucked in by the diesel engines blows through the compartments. And according to the testing program, the submarine was to spend a large part of the time on the surface, where external effects upon it and, correspondingly, upon the missiles in the launch tubes would be more considerable. And so, even though they understood that the forthcoming cruise was not going to be a walk in the park, and all the more so that the ship would be carrying fueled missiles, many of the industrial representatives were still eager to go to sea. The people wanted to be a part of everything that was associated with the birth of the new weapon, with no allowance given for age and health. Participation in the cruise was a matter of prestige for them. Besides Ivan Vasilyevich Popkov, who was a regular fixture aboard ship, Vladislav Khorev and Nikolay Vasilyevich Smirnov were along for the cruise. The latter, who was already rather old, and didn't fully meet the conditions of the cruise, insistently fought for inclusion on the list of its participants, and his wish was satisfied. Generally speaking, this was a manifestation of true patriotism and devotion to duty.

The day came to leave for the sea. Sergey Pavlovich was there among others to see us off. Parting with Ivan Vasilyevich and me, he said:

"Act boldly, if something should happen, I'll be with you: in a helicopter, in a torpedo boat, I'll be with you!"



And we knew that this would be so.

The cruise began on 16 August 1956.

The testing program, which was planned for several months, was full and complex. The submarine was to travel on and beneath the surface, at different depths and speeds. And checks and measurements were carried out in all of these travel modes. I. V. Popkov and his associates documented the vibration and shock loads on the missile in the launch tube with the help of recorders.

From the moment the missiles were loaded aboard and until the tests, an around-the-clock watch was held in the submarine's missile compartment by the operators of the launch team: A. G. Kuznetsov, K. M. Abrosimov, N. N. Tolstov and A. G. Yushkov. They maintained the missile storage conditions, monitored the state of the missiles, and regularly took air samples from the launch tubes in order to promptly detect any leaks in the missile fuel tanks, since this was precisely the thing from which an emergency could develop.

One night the "Fluid in Launch Tube" signal light on the launch tube state monitoring console went on. The submarine was on the surface, and it didn't appear that water could have seeped into the launch tube from anywhere, with the lid closed and the rack-and-pinion drawn tight. Could it really be that vibrations caused the tanks to leak, and one of the fuel components had started leaking? This was already serious. However, before sounding the alarm we decided to look inside the launch tube. Before doing so, we carried out a quick analysis of the launch tube's air. The analysis did not confirm presence of fuel vapor. This reduced the tension a little. Cautiously we opened the hatch at the neck of the launch tube, which is at the level of the missile's tail section. We listened and sniffed. It was quiet, there was nothing leaking, and no characteristic odors were present. In order to make absolutely sure that the integrity of the tanks had not been disturbed, I. V. Popkov decided to inspect the missile. He crawled into the launch tube through the neck, and wriggled into the ring gap between the missile and launch tube. I followed his lead.

Resting against protruding units on the launcher's retention posts, we inspected the missile along its entire height. We noted traces of something yellow leaking in the vicinity of the oxidizer tank's filling and drain valves. And in order to verify whether this was rust or oxidizer, the technical supervisor touched his finger to the leaks and then to the tip of his tongue. Was it acid? Yes, traces of acid! But the acid was not leaked at sea: The leaks were there after fueling, and had not been wiped off properly. The accident alarm was now unnecessary, and the testing could continue. We were glad for this back then, but recalling the incident today, I think that had an accident developed, getting out of the launch tube uninjured would have been improbable.

Regardless of the weather, the air samples taken from the launch tubes had to be transferred regularly to the trawler. This was especially difficult in fresh weather,

when the sea was disturbed; but the ship commanders, who maneuvered skillfully, never caused the sample transfer operation to fail.

The program also foresaw navigation in stormy conditions, and in September this possibility...[two pages of original missing].

...the necessary documents.

In its conclusion the commission noted that "the possibility for combat use of missiles and preservation of performance characteristics after lengthy transportation aboard a submarine under various navigation conditions...and the safety of the missiles to submarine personnel were experimentally confirmed." This was followed by the assertion that "a number of important experimental data necessary for further development of missile weapons and the ships carrying these weapons were obtained for the first time."

I was instructed to draft the commission's conclusions and proposals. I described the results of tests on all the systems, both those in the missile and the ship systems, in detail. The results were positive. However, on reading through this document, S. P. Korolev left the room saying nothing. He was displeased with something. I. V. Popkov soon came up and explained what the matter was. As it turned out, I had written about everything: the control system, the engine, the nose section, the launcher, and many other things; but I said not a single word about the missile as a whole. It did fly, after all, having retained its characteristics over a lengthy storage period in the submarine's launch tube, and it did hit the target. The remark was valid.

A few years later Popkov would recollect this lesson from the Chief in a similar situation during celebrations after successful completion of tests on a certain new army missile. After many fully deserved words of praise were spoken and toasts were offered in honor of the developers of the propulsion unit, without detracting from the commonly shared sentiments Ivan Vasilyevich reminded those present "that we shouldn't forget, however, that the engine is always in the tail of the rocket." Laughing, everyone agreed.

Soon after the cruise, Sergey Pavlovich asked me to prepare data on the conditions under which the tests had been carried out. Before leaving on his flight he wrote down everything about the cruise in his notebook: the total number of miles traveled on the surface and under water; the number of stormy days; the time spent on the bottom in deep water; the modes of travel; the results of test launchings, and other information. Apparently this was necessary for a report to be made to the government.

As he parted with me, Sergey Pavlovich thanked me for the work and invited me to visit him at the OKB-1, promising that he would "show me some interesting things." This is another of S. P. Korolev's typical traits. Supervising the joint activity of many organizations, and a work force totaling in the many thousands, he was able to also note the labor of a small group of people, and of a single individual, regardless of his position, and to

assess the contributions of such individuals to the common cause. Coming from the lips of this person, praise such as "You're doing excellent work!" was perceived as a high award.

Here is an interesting detail. Sergey Pavlovich didn't like it when participants of a test had to be replaced, and he always brought along insurance for novices, just in case. For example during the flight tests at sea in 1955, Major I. A. Zolotnikov, the chief of the launch team from the State Central Test Range, appeared at his request. However, his participation was not needed: N. V. Shaskolskiy mastered his new responsibilities in tests with the rocking test bed quite well, and moreover, he was also a submariner. It would hardly have been possible for a new person to master the particulars of submarine tests in the time available for doing so. Later on, in 1956, the story repeated itself. Korolev insisted on having N. V. Shaskolskiy come in from his new place of service to participate in test launches after the first month of transportation tests, but this time as an understudy for me. Very tactful by nature, Nikolay Vladimirovich cautioned:

"Don't pay any attention to my presence, I won't interfere in anything you do!"

I must say that neither N. V. Shaskolskiy nor I perceived this unexpected appearance of previously unforeseen understudies as mistrust, and neither of us were at all insulted. On the contrary, the high attention given to the role of the chief of the launch team was simply evidence of the degree of our responsibility.

All of this was fully explainable. After all, even the concept "prelaunch preparations" had just made its way into the lexicon of the submarine fleet. Also new was the occupation of submarine missile tester, and very little time was allowed to master it and to obtain the practical skills. Therefore it is no surprise that although Nikolay Vladimirovich and I successively learned our new roles quickly, and this could be seen perhaps as a positive thing, it could have appeared somewhat unusual to the outsider. Which is why launch supervisor S. P. Korolev decided to insure us with understudies just in case.

Why, one might ask, should the chief designer also have to burden himself with the question as to who would be the chief of the launch team? This was given over to the military, after all, and the should be the ones to worry about it. But he understood better than anyone the requirements that the person fulfilling these functions must satisfy.

To achieve efficient organization of prelaunch preparations, not only did the launch team chief have to know the sequence of all operations and be familiar with the overall testing situation in its relationship to all of the services of the coastal section of the launch area and missile impact zone, but he also had to have a clear understanding of the actions taken in all of the operations, in the way that an orchestra director must know the part played by each instrument. All the more so because all of the operations at the duty stations in the submarine's missile compartment, up to and including pressing the "Launch" button, were

carried out manually. Prelaunch preparations aboard submarines were automated much later. Moreover the reaction to what was happening also had to correspond to the swiftness of the prelaunch preparations, which required a certain amount of internal composure from the launch team chief as well.

By carrying out our responsibilities independently, without calling on the understudy, I feel we justified the trust shown in us by the command of the naval weapons test range and chief designer S. P. Korolev, the testing technical supervisor.

Contrary to test range deputy chief V. P. Mazurkevich's plan to write out the report locally, Korolev decided to do this not at the test range, but at the OKB-1, because that was where the materials he needed most were.

Three of us traveled together to Podlipki—V. P. Mazurkevich, V. I. Lebedev and I. Remembering his promise, soon after our arrival Sergey Pavlovich told Mazurkevich: "Pick a time, and I'll take you on a tour of our shops." However, Mazurkevich declined this gracious invitation with the excuse that we had to first study the materials for the report. A little while later, feeling that it would have been uncomfortable for us to resume that conversation, Sergey Pavlovich once again reminded us of his plan. This was an expression of his affection for us, and his certainty that we were actually interested in the work he was doing at that time. In addition this could be interpreted as his unique way of saying thanks for our participation in the past tests. It was precisely at that time that work was being concluded on the famous R-7 rocket, which carried the first Earth satellite into orbit in the following year, 1957, and then carried Yuriy Gagarin in 1961.

But in response to the repeated invitation Mazurkevich once again made the excuse that we were busy with the report. This could now be interpreted as tactlessness. It was as if the report wouldn't get written if we were distracted for an hour or so (and anyway, no matter how much Korolev would have wanted to, he wouldn't have been able to spare any more time himself); moreover, there was no strict deadline for writing it up.

"Well, all right then, but later on I might not have any free time."

It could be sensed from these words that he was insulted by the unconcealed disdain for his work and disrespect of him as a gracious host wishing to create a surprise for his guests. We felt very uncomfortable, and even ashamed for this, mildly speaking, absurd stubbornness of the chief, and a very great pity, of course, for the missed opportunity, one that could make itself available only once in a lifetime. This was Mazurkevich's way of expressing his displeasure with going on a trip to Podlipki that he didn't want to take, totally ignoring the enormous desire Lebedev and I had for seeing the new equipment. We were finally able to see the R-7 rocket, though unfortunately not in the flesh, but on a color poster in the office of the artists who were illustrating our report.

The R-7 was impressive not only in its unusual modular layout, but also in its 300-tonne weight and 30-meter height. When one hears the reminiscences today of different people about how enthusiastically Sergey Pavlovich discussed his plans for his dream come true, now embodied in metal, one could understand how tactless Mazurkevich was in refusing to hear what Sergey Pavlovich wanted to share with the seamen, whose reaction would doubtlessly have been of importance to him.

During the transportation tests we captured certain parts of the cruise on film on the submarine and from the accompanying trawler.

The film reel we put together was of course not very professional, but the harsh conditions under which the testing was carried out in Arctic seas, the dangerous maneuvers of the submarine and trawler during transfer of the air samples taken from the missile launch tubes, the decisive actions of their commanders, and the difficult work of the seamen were documented rather persuasively. We showed the film in the chief designer's office to members of the commission who had convened to sign the report. When the lights went on, Korolev, who had been sitting at his desk during the showing, remained silent, making no comments about the film. I feel that what we saw simply confirmed the difficulty and danger he foresaw in the tests and discussed with the naval commander-in-chief at a meeting in Moscow prior to their conduct.

After the spectators left the office, and Sergey Pavlovich turned to me:

"Ivan Ivanovich turned out to be an excellent commander! How do you feel?"

I confirmed his opinion.

The change in command of the submarine that occurred between the flight and transportation tests had troubled Korolev after all. And now, after the testing was finished, he had become conclusively persuaded of the good command qualities possessed by I. I. Gulyayev as well, and he did not conceal his approval.

Here is more about Korolev's attitude toward us, the seamen. During our work on the report we were put up at the hotel run by the Central Palace of the Soviet Army. Sergey Pavlovich was living then in Podlipki. On his orders, in the morning we were picked up by the ZIM belonging to his deputy, Vasilii Pavlovich Mishin, who lived in Moscow. The time on the road passed quickly in pleasant conversation with this very sociable person.

A year later the participants of the transportation tests who had gone to sea aboard the missile submarine were awarded the chest badge "For a Distant Cruise." Chief S. P. Korolev was also awarded this badge.

During all of the phases of the tests in which the naval weapons test range and the submarine participated, their personnel carried out all of the missions assigned to them. Not a single failure occurred for which they were to blame. The fact that this was the time when the principles of day-to-day operation and combat use of

ballistic missiles on submarines were laid should also be thought of as a most important result of this participation. These principles were subsequently reflected in manuals, regulations and combat instructions.

The experience acquired by naval seamen also made it possible to formulate the basic requirements on naval missile bases and work out the organization of their services. When such bases and combined units began to be established for missile submarines in the Northern and Pacific fleets, the problems of their initial development were solved much more easily, because all of the organizational and technical documents were already in existence, and moreover, the experience that had been acquired by naval specialists allowed them to provide real assistance to their comrades-in-arms in preparing for and conducting missile launchings from newly commissioned submarines.

In terms of their volume and the results, and given the minimum losses of tested equipment, the tests conducted for the first time in 1955 and 1956 under such a tight schedule could be thought of as exemplary in the organizational aspect.

#### We Take the Hit

The naval command and life itself continued to pose more and more new problems before the weapon developers.

The positive results of the transportation tests were obtained under the ordinary—if we could call them that—conditions of independent sailing of submarines. But how would the weapons behave in the face of enemy action? How would the weapons stand up to the loads imposed by explosions? How would this reflect upon the combat capabilities and viability of the ship, and the safety of its personnel? Because construction of a small series of class AV-611 missile submarines had already started, not only had these become important questions, but they also had to be answered quickly.

Later on, when the next missile was being created for class 629 submarines, a special compartment containing RO-629 launch tubes was set up to test the weapons for blast resistance. But this did not occur until 1960. In 1957 the only possibility for conducting blast resistance tests was to use, once again, the submarine "B-67". These tests were dangerous both to the personnel and to the ship as a whole. In order to diminish this danger we proposed the following measures:

1. The missiles were to be fueled not with fuel components but with neutral liquids with specific gravity and viscosity close to those of the standard oxidizer and propellant.
2. Personnel were not to be aboard the submarine during explosions of depth charges.

While the first measure did not present any special difficulty, the second required coming up with a means by which a submarine could stay submerged without people aboard.



In fall 1957 the submarine "B-67" arrived in one of the bays of the Gulf of Kola, where the a proving ground had been set up for the forthcoming tests. Engineer-Captain 1st Rank F. S. Shlemov was the chairman of the state commission, and his deputies were Captain 3d Rank I. I. Gulyayev and OKB-1 lead designer I. V. Popkov. V. G. Babulin, N. L. Moshenskiy and I. A. Lashmanova, depth charge specialists and divers from the Northern Fleet's main base, and other comrades took part in the commission's work. According to the program, the explosions of the depth charges were to occur at different distances from the submarine and at different depths of their placement.

The submarine was submerged in an unusual way. A huge weight was attached to the submarine in the vicinity of the midship-frame. The length of the line attached to the weight determined the depth of the submarine. The submarine was trimmed with slight positive buoyancy. Thus after the main ballast tank was filled, the submarine submerged in response to the weight, but as soon as the weight touched the bottom of the sea, the submarine stopped descending, and it hovered at the prescribed depth. Such was the plan. But it was still impossible to carrying that out without the participation of personnel. This is where great skill and courage were displayed. Prior to submerging the submarine, the personnel opened up the Kingston valves of all of the main ballast tanks and the vent valves of the end-group tanks. The submarine went from surface to trimmed-down position, and the personnel transferred to a launch. Two persons remained aboard the submarine—its commander, Captain 3d Rank I. I. Gulyayev, and the engineering department commander, Senior Engineer-Lieutenant A. F. Agapov. They inspected all the compartments, and checked the condition of the fittings of sea water intakes. After making sure that everything was in order, the commander ordered the mechanical engineer to open the vent valve of the middle tank. The submarine began submerging, and the deck disappeared from beneath the legs of the testers. Closing the upper and lower conning tower hatches, they abandoned the submarine as it descended beneath the water. There were just a few minutes left to carry out these operations, and in this time they had to ensure that the ship was watertight, and then jump to the launch. Any delay or mistakes carried the threat of serious consequences.

After a depth charge was exploded, the divers went into the water and turned on the air hoses to purge the end-group tanks. The submarine surfaced to trimming-down position, and the personnel returned to it. The ballast tanks were purged, and the ship finally surfaced all the way. These are the kind of operations that had to be carried out for each successive experiment, and there were many experiments. After each one, the missiles in the launch tubes were inspected for the absence of fluid leaking from tanks, and their onboard apparatus was checked out. The state commission concluded from the results that the missiles did have the needed blast resistance. They remained combat capable after explosions occurring at a safe radius, and they remained safe when explosions occurred at the critical radius for the ship. Thus the missiles do not detract from the fighting qualities of the submarine as a whole.

After the tests ended, the submarine, which had sailed from the Barents to the White Sea, returned to its permanent base under its own power. Once again our flagship successfully carried out its mission in comprehensive testing of the new weapons.

#### **'Boards Beneath Our Feet, Cod In Our Stomachs, and Melancholy in Our Hearts'**

One of the factors of successful completion of all phases of this work was the drive and selflessness of its participants. The people took no note of and simply ignored all of life's difficulties, they were unassuming, and they kept a sense of humor about their personal discomforts.

V. P. Finogeyev described the living conditions in the North using the saying that was in circulation at that time: "Boards beneath our feet, cod in our stomachs, and melancholy in our hearts." By the way, there was no time for melancholy, and all things spiritual were secondary to the work.

As for the "boards," the saying rings true: Not only were the sidewalks made out of boards, but the road to the test range's central area was also wooden. A log road stretched across the marsh. It consisted of timbers sawn lengthwise and laid with the flat side up. The log road was wet and slippery, at all times of the day and during most of the year—from rain, snow, black ice, from water seeping up from beneath as vehicles passed. Walking on it was not a pleasant thing to do. Getting one's feet wet wasn't the worst of it—the danger lay in something else. The road was narrow and unlit, such that a wrong step to the left or to the right, and the traveler could find himself in the water, the depth of which depended on his own luck of the road.

This fate befell a certain mild-mannered officer, a meteorologist by specialty. Once in the darkness, as he was returning to the unit, he unwittingly strayed to the side and splashed into the water. How he was able to get out, he didn't say, but he certainly astounded the duty detail when he appeared at the checkpoint looking like some aquatic creature, covered with pond scum and weeds. He replied to the reaction of the duty officers with a restrained smile, and marched toward the unit without explanation.

By the way, Aleksey Mikhaylovich Isayev, an extremely modest person and the chief designer of the missile's propulsion unit who came for the tests in 1955, made the daily round trip on this road on foot.

As far as "cod in our stomachs" is concerned, that's true as well. Even then, the food was bad, but on the other hand the store shelves were filled with 50-proof vodka and drinking alcohol. And of course there was also the well known Edelman Restaurant. Its prosperous director knew how to feed visitors with tasty food and for not too much money in those difficult times.

Housing was also a difficulty. Test range officers were accommodated in a dormitory in prefabricated panel barracks without any conveniences. They were awfully cold in winter. People had to sleep with their clothes on, covering themselves with a second mattress. There was no hot water in the unit, and it was hard to get into the

communal bath. Overall, washing was a pain. Once an officer from the naval weapons test range managed to get a turn in the shower stall. To capitalize on his unprecedented luck to the fullest, he decided to simultaneously do his laundry. Naturally this required more time than was allowed. The "unwashed" waiting at the door began growing impatient. Our hero did not respond to their mutterings. They guessed from the characteristic splashing of the water that he was washing his underwear beyond the door. The cup of patience overflowed. The waiting bathers began tearing at the door, appealing to conscience, and threatening reprisals. You can imagine their astonishment when the door opened after a little while and this aficionado of "Chinese laundry" emerged from the stall in a fully buttoned tunic and a rakishly donned cap. Gazing in amazement at his besiegers and imperturbably waving his washrag, he sauntered by them carrying only a towel and soap dish in his other hand.

The bathhouse dressing room had the look of a tableau: What happened was simply improbable!

But actually, everything is explained quite simply. The laundered underwear had not disappeared. Wishing to avoid a scandal, the culprit of the conflict put it on wet over a fresh set and then covered it all over with a uniform.

Guests were accommodated somewhat better. They were put up in the support ship "Aeronavt". This was a German trophy vessel. A telemetric station was installed aboard, and during test launches the "Aeronavt" also steamed to the launch site vicinity. There were many cabins in the ship, and therefore it was very comfortable: This was both a hotel and an observation deck from which to observe launching of the missiles. But even here, guests did suffer some unpleasantness.

By ancient naval tradition, the "Aeronavt" had a female bear by the name of Mashka as a mascot, a quiet, friendly animal, and the beloved of the crew.

Once a certain guest, a scientific associate, decided to tease her. Mashka charged the would-be trainer. Losing his nerve, the self-assured "Filatov" in an officer's uniform was off like a shot. Displaying unexpected daring, he slid down the ladder to the messdeck, and running the entire length of the corridor along the cabins, he hastily took shelter in one of them. Having lost sight of her offender, Mashka flew to the first open door. At this time another scientific associate, who was standing happily beside an open porthole, was pulling one smelt after another out of the sea. Because this enterprise didn't require any brainwork, he was concurrently immersed in creative thought. Moreover the fish were biting, which "abstracted" the fisherman even more.

One can imagine his state when he was confronted by Mashka's growling muzzle. He shot like a rocket up to the tabletop and from there into the upper bunk. When Mashka rose up on her hind paws, all the scientist had with which to defend himself against the raging bear was those same scientific thoughts, expounded on paper and

collected together into a folder—the weapon of an intellectual. It's hard to say how it all would have ended, had seamen from the "Aeronavt" crew, whom Mashka trusted, not hastened to the commotion.

#### A Successful Examination

Two design offices headed by chief designers V. P. Makeyev and N. A. Semikhatov were established for series manufacture of R-11 and R-11FM missiles, and to support further specialization in naval weaponry.

Viktor Petrovich and I met for the first time when he came to the naval weapons test range toward the end of the transportation tests in 1956, and participated in the final meeting of the state commission. Later on I met with him and Nikolay Aleksandrovich on several occasions, the last time once again in the North, in the mid-1970s.

Upon accepting all of the technical documentation from their parent organizations, the new collectives quickly mastered the procedures and set up production of the missiles. In order to check out the technological reliability of series-manufactured missiles and train the engineers and technicians under test range conditions, a decision was made to carry out flight tests of the R-11FM missile with that same SM-49 rocking test bed at the State Central Test Range in Kapustin Yar.

The state commission was headed by Gleb Mikhaylovich Tabakov, who was at that time the director of a scientific research institute testing the propulsion units of all newly designed ballistic missiles. This institution was perhaps even more dangerous than the test range in terms of the probability and actual frequency of accidents, because rocket engines were started up for the first time on its test beds. The unique features of the work probably made their impression upon the character and even the countenance of G. M. Tabakov. He was strict and demanding, he was of stern appearance, and he always seemed displeased with something. It was my fate to meet him once again 14 years later, when he was deputy minister, and a Hero of Socialist Labor.

It cannot be asserted that the leadership led the young chiefs by the hand in their first field work, but they did stand beside them in order to help out when help was needed. Lev Arkhipovich Grishin, one of the main directorate chiefs, was almost constantly present during the testing, and Sergey Ivanovich Vitoshkin, the deputy chairman of the GKOT [State Committee for Defense Engineering], also attended toward the conclusion. These were executives who were well known in the sector, with a long career and considerable experience, and they were pioneers of Soviet missile building. Their advice was doubtlessly useful to the young.

A newly established division headed by Engineer-Captain 1st Rank Nikolay Nikolayev Zheglov, a competent specialist and an officer with outstanding command qualities, was servicing site "4a" with the rocking test bed in 1957. Upon close acquaintance and communication, he was found to be a simple, happy and keen-witted person.

My comrades—naval seamen A. A. Zuykov and Yu. M. Stepanov—and I were members of the state commission.

I must say that this work proceeded in organized fashion and quickly right from the start. There was perhaps but one case of trouble and a short delay in testing.

The missiles were loaded into the launch tube of the test bed by means of a truck-mounted crane with a long boom. The height to which the missile had to be lifted equaled, in addition to the length of the missile itself, the height to the top of the launch tube, which towered around 12 meters above the ground.

The day for one of a series of launchings was approaching, but the crane wasn't working: The brake controlling vertical movement of the hook was slipping. It was fixed several times, but after a while the fault reappeared. The problem came to the attention of the high command. Lieutenant Andreyev (for some reason I've remembered his name), the load-handling chief, was chewed out, even though this was a very disciplined and responsible officer.

Put out by the insufficient attention displayed by persons responsible for operation of the load-handling equipment, commission chairman G. M. Tabakov expressed his anger, promising to report all of this to Moscow.

After the test range chief engineer's assurances that the crane was fully serviceable, Tabakov decided to have the missile loaded into the launch tube.

The operation began. The crane was controlled by a soldier, and Andreyev stood beside the crane. Once the missile was suspended off the ground, its raising was started. We were all not far from the test bed. The missile ascended ever higher, finally attaining the required height, and all that was left was to it over to the launch tube and set it down on the launch stand. We watched the operation with our heads raised high. Then suddenly the missile began descending on its own: The unfortunate brake wasn't holding after all. The speed with which it descended toward the concrete slab increased. The missile's tanks were already filled with the fuel components. The danger of their rupture upon impact was a real one. There was nothing we could do, and so we abruptly scattered in all directions. The time all of this took was actually much shorter than the time it takes to tell this story.

Andreyev was up in the crane cabin in a single leap, and he was able to slow the descent speed down somewhat, but the missile's tail struck the concrete anyway with a cracking sound. Upon touching down, the missile began tilting, and were it now to slide along the concrete slab, rupture of the tanks would be unavoidable. The missile had to be kept from sliding somehow. The commission chairman found the solution. He grabbed a length of hemp rope that was luckily lying nearby, tied one of its ends to something and threw the other around to the other side of the missile, which I then secured. This stopped the missile from slipping off of its point of support. An accident didn't occur, but two out of the four control-surface actuators of the gas vanes at the engine nozzle outlet were knocked out of service.

The missile was laid on the bed of the transporter, and the control-surface actuators were replaced right there, on the launch pad. I remember chief designer V. P. Makeyev participating in this work as a fitter, and together with him, his reliable assistants—G. S. Peregodov, L. M. Kosoy and V. L. Kleyman. It is interesting that the results of the launching of this restored missile were outstanding.

Tests on the combat equipment required efficiently organized work, constant composure and attentiveness, especially in everything having to do with safety, from everyone. Neglect of these seemingly obvious rules could have meant accidents.

Thus, there was this extremely instructive incident during preparations for one of the launchings: The missile had been positioned on the launch stand, the posts of the retention unit had been brought together, and its locks had been closed. Now in order to free the missile from the crane the stand had to be lowered so that the straps could be disconnected. Care had to be taken at this time to see that the hook was kept slightly loose, since if the stand were to be lowered and the hook were to remain motionless, the missile would begin moving upward relative to the posts of the retention unit as during a launching, the locks would open, and the posts would spread apart, causing them to impact against the launch tube and become unserviceable.

The work was under the supervision of Engineer-Lieutenant Colonel I. A. Zolotnikov. As luck would have it, many people had gathered on the narrow circular bridge at the top of the test bed's launch tube. What had to happen, did. The crane operator didn't ease off on the hook in time, naturally the cable grew taut as the stand descended, and it began pulling out of the launcher. The locks opened, the posts spread apart instantaneously, coming to rest almost against the railing around the bridge. It was simply a miracle and a stroke of luck that there were no people at the points on the bridge in the path of the posts, and everyone remained alive and healthy. After all, the force with which the posts spread apart was 7 tonnes.

Igor Aleksandrovich was the first to regain his composure. Probably imagining the possible consequences and cursing himself for allowing extra people on the bridge contrary to his usual strict observance of safety rules, he chased everyone off without mincing words. The miraculously spared observers scrambled down the ladder, probably surpassing all of the fire norms. This also was a practical lesson for us.

The mechanism spreading the posts of the retention unit, the heavy lid of the launch tube, and the deep, large-diameter launch tube with the movable launch stand inside were all very dangerous structures, which was revealed later on unfortunately in the course of operation of submarines in the fleet.

Successful completion of the tests confirmed not only the dependability of the structures and systems taken over by the succeeding organizations, but also the maturity of their collectives. Using naval terms, they successfully



passed the tests for standing their watch independently, for which we enthusiastically congratulated V. P. Makeyev, G. S. Peregudov, V. L. Kleyman, N. A. Semikhov, N. S. Domrachev and many others.

A banquet was organized on this occasion. The "celebratory part" was followed by performances. Tales of the sea masterfully presented by N. N. Zheglov were followed by songs. A choir sang a song about Leningrad (obviously in honor of the seamen), "Blue Sky Over Russia." The young, pleasant voice of the lead engineer, Vladimir Kleyman, could be heard above the rest, and after that, to the surprise of all, Gleb Mikhaylovich and Lev Arkhipovich performed together in a tap-dance. They danced so well together the impression was that they weren't doing this impromptu. Each dancer had his own style. Lev Arkhipovich danced with a flair, with Russian daring and a broad smile. Gleb Mikhaylovich, who maintained his customarily stern expression even while dancing, recalled a stand-offish, imperturbable Englishman. Together they presented a surprising and marvelous picture. The people knew how to work hard, and play well.

This was my first and last meeting with Lev Arkhipovich. He died in 1960 from severe burns in that accident I mentioned earlier, at the Baykonur Cosmodrome.

#### Missile Submarine Brigade

1958 became the year of adoption of series-manufactured class AV-611 missile submarines designed on the basis of class V-611.

Four ships were brought together into a brigade in the Northern Fleet. The first task force consisted of the submarines "B-73" (commander—Captain 2d Rank I. S. Likharev, gunnery department commander—Senior Lieutenant Yu. I. Murashin), "B-78" (Captain 2d Rank V. V. Gorontsov, Senior Lieutenant A. G. Tumanov), "B-79" (Captain 2d Rank V. G. Smirnov, Captain-Lieutenant K. B. Kuznetsov), and "B-89" (Captain 2d Rank N. F. Khanin, Captain-Lieutenant V. S. Kalinin).

Seeing these giants standing at floating moorings beside the hills, I was overtaken by a feeling of pride for the country, its people, and all who played a part in the advent of such a menacing force in such a short time.

The brigade was under the command of Captain 1st Rank Sergey Stepanovich Khomchik. The brigade commander wasn't even forty yet. Having come to the navy from naval school, he had managed to experience all of the difficulties of combat cruises, and as a consequence he himself was aggressive and impetuous. Sparing neither himself nor others, he did everything possible and impossible for the brigade's initial development. Possessing fabulous organizational capabilities, he was able to be everywhere at once, and the exemplary order he established could be felt everywhere. The careful nature of his character revealed itself as well.

I made my first visit to this brigade in January 1958 together with Senior Engineer-Lieutenant K. M. Abrosimov. The goal of the trip was to provide assistance to the

personnel in drawing up the instructions for all of the action stations in the gunnery department for the forthcoming missile launch tests. Capitalizing on the opportunity, we also conducted lessons for the staff officers and submarine commanders, who were interested primarily in how to prepare the initial firing data and aim the missile toward the target prior to launching.

By coincidence this was also the time when annual combat training sessions were being conducted in Polyarny for all naval submariners, and we were invited for a demonstration of the missile weapons of one of the brigade's submarines. Submarine aces of the past war gathered together in the missile compartment: S. P. Lisin, Yu. S. Bodarevskiy, P. A. Sidorenko, A. M. Gontayev, and others. There also I met Northern Fleet commander Admiral A. T. Chabanenko, who reminisced about the launch tests held at sea in 1956. Events were occurring so swiftly that they quickly became history. Missile submarines were no longer a mystery to submariners. They became something understandable, something of their own, and something ordinary.

A missile service was organized in the fleet. This was a new, difficult and important enterprise. Captain 3d Rank I. V. Gorkunov made his appearance in the missile submarine brigade as the chief specialist in missile weaponry. He was a very competent specialist who devoted considerable effort to introducing the new ballistic missile systems. These same functions were carried out in the submarine forces of the Northern Fleet by Engineer-Captain 2d Rank G. P. Lazurenko. I was well acquainted with this deeply honest person and well-organized, intelligent officer. Earlier I had replaced him as the mechanical engineer aboard the submarine "M-200" in the Baltic, and later on we studied together in the academy. When people say that it's a small world, this is especially true of the navy.

The last operation, which concluded the extremely long list of trials of each ship, was missile test launching.

The submarine "B-73" was assigned to carry out flight tests of a series-manufactured R-11FM missile. There were no doubts in the results of the tests, all the more so because the missile had been checked out in the preceeding year at the State Central Test Range. The main goal of the tests was to work out the organization of the missile service of the submarine brigade, coordinate it with the fleet's missile engineering base, and carry out the launchings themselves with the participation of specialists from industry. The experience acquired by the latter helped them to adapt the new weapon-developing organizations to the conditions and unique features of the navy.

The tests were conducted by a state commission. It was headed by Northern Fleet submarine forces commander Vice-Admiral Aleksandr Yevstafyevich Orel, a Baltic submariner who acquired fame during the war. Chief designer V. P. Makeyev was his deputy and the testing technical supervisor.

Ship builders were represented on the commission by assistant chief designer Vladimir Vladimirovich



Borisov. The commission members were L. M. Kosoy, V. A. Vnutskiy and P. M. Zelentsov. Despite the fact that all of the technical documentation on the missile system had been transferred to other design offices, S. P. Korolev continued to attentively follow the first independent steps of the succeeding organizations, and was prepared to assist them. This is why representatives of the OKB-1—lead designer I. V. Popkov and division chief P. V. Novozhilov—also worked on the commission. Naval seamen were represented on the commission by V. M. Kosmin, Yu. M. Stepanov, Ye. Ye. Shurmelev and myself.

All members of the commission, of course with the exception of its chairman, who lived at home, and the participants of the testing were accommodated in the training detachment's barracks: commission members in the smaller building, called the "small tent," and everyone else in the "big tent" with double bunks. As always, the personal conditions of the testers were generally significantly inferior to the level of the equipment to be tested.

Time dragged slowly in the "tents," because our work went on around the clock, and it was not an easy thing to fall asleep, even though we were tired. In order to hasten the process of falling asleep, somewhere our colleague Ye. Ye. Shurmelev acquired a volume of the Marine Astronomical Annual, consisting of tables filled completely with figures characterizing the positions of the stars. Upon going to bed he would open the volume to any page arbitrarily, and begin going through the tables carefully. After a short while the numbers would do their work, his eyes would begin closing, and the "stargazer" would fall asleep.

I should note that the preparations and conduct of the tests were somewhat simpler than in 1955. First, we already had the appropriate experience, second, the launch site did not have to be equipped in any special way—a buoy was simply positioned at the launch point, and third, while we used the test range's missile impact zone we fired into it from another direction.

When it went out to sea, the launching submarine was accompanied by the ore carrier "Ponoy" with a telemetric station and equipment of the timing service in its hold. Telemetric monitoring was necessary at these test launches essentially only to clarify the cause of an unsuccessful launch (an accident or excessive deviation of the point of missile impact from the aiming point). When the missile landed within the prescribed quadrant, the telemetric recordings lost their importance.

We began launching the missiles. One of the launchings was unsuccessful. After the reason was analyzed, the tests were continued. As was true of his teacher S. P. Korolev, young chief designer V. P. Makeyev went to sea with the submarine, and quickly worked himself into the routine. Successful mastery of the series-manufactured missile and the positive results of its flight tests reinforced his faith in the possibilities of his collective. The next missile, which was created independently, with a range four times greater than that of the R-11FM, was almost

ready. Tests on the missile with a submarine of another class were to begin late the following year.

Once late in the evening, when the sky was decorated by the northern lights, three of us—V. P. Makeyev, I. V. Popkov and I—were having dinner in the Red Nook of the training detachment. In a confidential discussion Viktor Petrovich shared with us his innermost ideas regarding development of missiles that could be launched from beneath the water. The navy would be receiving such a missile in very short time. The new models designed by the young collective began entering the navy after a relatively short time.

I would like to also say a few words about S. S. Khomchik. He was soon promoted to rear admiral, and then sent for training to the Academy of the General Staff. This was a promising military commander, and he had a successful career ahead of him. However, after graduating from the academy Rear Admiral Khomchik was unexpectedly appointed first as commander of a brigade of mid-sized submarines in the Pacific Fleet, and then as chief of the Training Detachment in Vladivostok. This appointment was an undeserved demotion for him, but most importantly, it meant a great loss to the submarine missile fleet, for which many friends who knew him were sorry.

Prior to the conclusion of all the tests I was recalled to the Pacific Fleet, where the lead class AV-611 submarine was being commissioned in this fleet.

I didn't want to leave. Overall, the tests were proceeding successfully, I was doing useful work, around me were my friends, and avid patriots in their specialty, and I felt at ease and confident in their presence. In a way, I had also become used to living in the natural environment of the Far North. The gloomy, dark, rocky hills were covered with bare, rounded rocks—traces of the violent work of wind and water. Hills, hills for hundreds of kilometers in all directions—even in May they weren't entirely free of snow yet, and consequently the dominant colors are black and white. Harsh nature. And when the boat leaves its mooring, the urge arises to go to the side, and take one more look at the shore, this time from the sea, and say goodbye to it. The boat traveled right next to the rocky shore, which plunged steeply, almost vertically to the sea. It was sad to part with these cliffs, with the dark cold water, with the land on which one has lived among people unspoiled by either nature or their work, a land that may be uninviting in its appearance, but which had taken you in. This was also a chunk of one's motherland, and no matter where one was, be it the woods around Moscow, or the steppes of the Volga, or the hills of the Arctic, it was still the motherland. Lines from a favorite wartime song of Northern Fleet seamen involuntarily come to mind:

"Farewell, rocky mountains, ...!"

Sixteen years later this song was to be sung by chief designer V. P. Makeyev to his own guitar accompaniment at the request of his associates on his 50th birthday, and all who were to gather together in the great hall of the Palace of Culture would back him up. This would be an

expression of their feelings for the navy, to the strengthening of which they had devoted both their efforts and their souls.

#### **Fleet Missilemen**

My temporary duty with the Pacific Fleet was interesting and important to me. Interesting because this was the only fleet that I had never visited before, and important because tests of this kind were to be conducted there for the first time, and the command had sent me to assist in preparing for them.

Specialists from the Northern Test Range were summoned at my request. Moscow was to be the gathering place. This group included: Engineer-Captain V. P. Maslakov (a specialist on rocket fuel), Senior Engineer-Lieutenant Ye. A. Bykov (propulsion units), Senior Lieutenant V. S. Koshelev (communications), Engineer-Lieutenant E. V. Ivanov (control systems), and Senior Lieutenant E. A. Denisenko (missile impact zone). Meeting at the hotel of the Central Palace of the Soviet Army, we took off for Vladivostok soon after. A little while later the assistance group was enlarged. I. V. Popkov and the imperturbable, good-natured P. V. Novozhilov, who would on occasion kid us for our youthful zeal, flew in. A. Kuntsevich appeared from the NII-49. V. P. Makeyev's design office was represented by sensible and energetic V. I. Shuk. Overall, this was a strong group of specialists, persons of like mind who could understand one another intuitively.

This trip of mine had a double objective. As a member of state acceptance I was to take part in tests on the missile system of the submarine "B-62". And in my role as lead associate of the Naval Institute, to which I had been transferred in late 1957, I was obligated to help the naval missilemen, and primarily the personnel of the newly established test range, in organizing the preparations for and conduct of the first missile launching from this submarine.

As for the first direction of my activity, it had its start in the Pacific Ship State Acceptance Group (abbreviated TGGPK). Captain 1st Rank Boris Maksimovich Margolin was appointed chairman of the state acceptance commission for the submarine "B-62". A submariner who had fought on the Black Sea, he served as a submarine commander, after which he commanded a submarine brigade in these parts, and now he was the senior authorized representative of the TGGPK. This was an independent, erudite and decisive officer, though somewhat self-opinionated as well, perhaps because during the period of state tests on a ship, the commission chairman was subordinated directly to the naval commander-in-chief. Margolin was simple, democratic, and keen-witted. One of his traits that served as an object of our disputes was his tendency to simplify the task of acceptance of the missile system, to reduce it to the established procedures of testing ship weapons and a ship as a whole. I did not always agree with him, for I saw certain things unique to missile weapons that contraindicated a simplified approach.

Generally speaking, in contrast to flight tests of missiles, tests conducted by the ship state acceptance commission had unique features. The fact is that while in the former all attention was concentrated on launching of the missile and its impact in a prescribed quadrant—that is, the missile was the object of the testing, now the ship became this object, and the missile was in a sense the means of testing. All of this is of course conditional—it's difficult to imagine a missile playing such a role, but the focus was changed. Much attention had to be devoted to the ship systems of the missile system, to the consistency of their output parameters with the prescribed characteristics, the convenience of their operation, their dependability, sufficiency of spare parts, tools, and accessories, and so on. In other words the tests were being conducted not with emphasis on launching, but in order to check out ship systems by launching a missile.

The disagreements that arose with the chairman were basically organizational in nature. And the benefit from them was, I think, mutual. The mutual understanding we acquired was subsequently confirmed by two instances of my appointment to state commissions at Margolin's request for the acceptance of the lead missile submarines of subsequent classes for the fleet: in 1959, and 10 years later in 1969.

The testing program and other documents we had drawn up earlier were updated and supplemented. The future organization of tests on series-manufactured ships of the given class was studied and established during tests on the lead ship. Tests conducted under the supervision of S. P. Korolev and N. N. Isanin were our model for such organization, and together with I. V. Popkov we worked persistently for its introduction into the navy. Poor organization not only engenders mistrust in the new equipment and causes testing to drag out and go off schedule, but also harbors consequences of greater seriousness, because the tests are conducted on combat equipment, on weapons. Moreover, ship personnel acquire their first experience in missile launchings in such tests.

Everything was generally proceeding well in the preparations of the submarine "B-62" for the tests. Standard checks of the weapon system were being carried out, and faults were being corrected. Of course, entirely new questions for which the instructions did not contain any answers arose as well. In these cases we had to act as the situation dictated, and, by the way, as was recommended in a document inserted under the glass desk-top of the TGGPK chief, Captain 1st Rank N. Streltsov.

"Extract from NTK Shipbuilding Circular No 15, 29 November 1910.

"Instructions for ship engineers observing construction of vessels at government and private plants.

"Paragraph 2. No instructions can list all of the duties of an official, foresee all individual cases, and provide the corresponding direction in advance, and consequently observing engineers must display initiative, and guiding themselves by their knowledge of their specialty and by

what would be beneficial to the enterprise, they must apply all efforts to justify their position."

You can't deny that specialists of the Russian navy were wise.

Things went normally aboard the submarine during preparations for the testing owing in large part to its commander, Captain 2d Rank Viktor Ananyevich Dygalo. This was a competent naval officer who was excellently prepared to fulfill his functions. He was sociable, he had a child's mischievous streak in him, and he had a great love of life. Now there's a combination. Reminiscing about him now, a quatrain from the "Aeneid" in Kotlyarevskiy's translation, in which the author describes the main character very broadly and figuratively, popped into my mind:

[transliteration; original is not in Ukrainian]

Eney buv parubok motornyy,  
I khlopets khoch kudy kozak,  
Zibravs na vseye zle provornyy,  
Zavzyatishiy vid usikh burlak.

Dygalo's diverse capabilities revealed themselves in subsequent years. In 1959 he conducted a successful demonstration launching for N. S. Khrushchev, in which I also had the fortune to participate. After studying in the academy he assumed command of a submarine division, after which he became editor-in-chief of the journal *MORSKOY SBORNIK*. I met him once again in the early 1970s, when he was a rear admiral serving as deputy chief of the scientific testing center, and then when I was supervising the testing of a new missile in one of the parts of the center in my capacity as assistant chief designer. He had not changed—he was just as energetic and affable as before.

One other commission member who served on submarines and with whom I interacted closely from the very first was Captain 2d Rank Vasilii Tikhonovich Pozdnyakov, the top specialist in the missile weapons of naval submarine forces.

This was the first time he was taking part in such work. This was as yet the only missile submarine in the navy, and he devoted all of his time to preparations for the tests. He was curious about everything, and he tried to help. Owing to his active participation, no problems ever arose on the part of the submarine forces command: It trusted in Vasilii Tikhonovich completely. He was pleasant in his demeanor, and I always remember good things about him. I would hope that Vasilii Tikhonovich learned a few things from us, and that this helped him in his subsequent service.

Gunnery department commander Senior Lieutenant Albert Vasilyevich Bardinov and control group commander Senior Engineer-Lieutenant Anatolii Viktorovich Klemmin were the submarine's missile officers. Both took the testing seriously, and they prepared the personnel and materiel for it well. They were attentive to advice and recommendations.

The second direction of my activity on this trip was associated with the navy's Missile and Artillery Directorate and the test range. In his time the directorate chief, Captain 1st Rank Vasilii Platonovich Solov'yev, was the top gunner of the Black Sea Fleet, he fought in the war, and he earned many decorations. He was an open, broad-minded military commander who didn't micromanage. His outward appearance was that of a real ship gunner, aristocratic and imposing. He put his complete trust in us, as specialists who had come to take part in the forthcoming missile test launchings.

Also among the directorate division chiefs was Nikolay Nikolayevich Tolstov, already familiar to the reader as a member of the launch team at the Northern Test Range. He was a very active and knowledgeable officer. He was responsible for weapon preparation aboard the submarine, and he knew his business fabulously.

The newly established test range was under the command of Colonel Anatolii Semenovitch Pasechnik. A very modest and restrained individual, he also fought in the war. While he did have a tremendous amount of work to do in regard to development and manning, he was able to handle it successfully, and maintain proper military order in the unit.

My work brought me in contact most often with the chief engineer of the test range, Engineer-Captain 2d Rank Nikolay Andreyevich Strakhov. The entire weight of technical issues lay upon him, and he was able to resolve them, never losing his presence of spirit. He was always dynamic and alert. He was an outstanding organizer who wasn't afraid of responsibility for his decisions, and who boldly defended them at all levels. He was strong in character, but this wasn't an obstacle to our joint work, because he was first of all a conscientious worker.

#### At the Fleet Commander's

Having acquainted myself in detail with the situation, I became persuaded that the order published earlier by the fleet commander regarding preparations for the first missile launchings from the submarine had not been fulfilled in regard to a number of items. There were delays in setting up the launch site and the missile impact zone. What made this work difficult was that these facilities were a significant distance from the test range and the fleet's main base. The geographic features of the selected regions, to which equipment could be delivered only using assault landing vessels and aviation, also added to the difficulty. The order concerned itself with the initial phase of preparations for the tests.

A kind of uncertain situation came into being, in which measures that had not been completed on time and which remained unchecked were now proceeding on their own, spontaneously. Knowing from experience approximately how much time is needed for full deployment of all naval forces and resources, it was not difficult to determine that the delays would make it impossible to meet the deadline set by the naval commander-in-chief—the month of September.



Something had to be done to get the preparations moving, the attention of the fleet command had to be attracted.

Then by remarkable coincidence such a needed meeting occurred one day with Pacific Fleet commander Admiral Vitaliy Alekseyevich Fokin. The commander visited the service area of the test range, toured all of the buildings, and carefully inspected them, making certain remarks, among which I remembered him saying that "we need to build to last a century." In distinction from the Northern Test Range (sufficient time had been allocated for construction here), all of the structures were of masonry construction, they were well-built, they were connected together by concrete roads, and the ground was different—it wasn't marshy.

I introduced myself to the commander, told him who sent me to the fleet and why, and requested an audience with him to report my assessment of the state of affairs, and my proposals. The admiral set up the meeting for 3 days later at fleet headquarters. The discussion proceeded in the presence of A. S. Pasechnik and N. A. Strakhov. In order that the forthcoming meeting would result in more than just conversation, I decided to draft a new order. I coordinated it with the leadership of the test range, though in my opinion it didn't have much faith in the effectiveness of my actions.

At the appointed time I arrived at fleet headquarters, and was soon admitted to the commander. Although there was a "distance of enormous proportions" between us in rank and position, the admiral came out from behind his desk, shook my hand, and asked me to sit down across from him. In order not to take up too much of his time, I immediately handed him the draft order. The commander began reading it carefully. This was a long document—12 pages. It not only set targets for the fleet services involved, but also indicated the place and role of each service in reaching the end goal of the entire operation. The draft was drawn up with reference to the concluding phase of the operation. It contained no organizational conclusions connected with the failure to fulfill certain measures in the initial phase by the deadlines indicated in the earlier order, but the deadline for completing the entire operation was left as before, corresponding to the directives of the naval commander-in-chief. Such that the laggards would have to mobilize, and they would have to work at a forced pace.

I surveyed the admiral's office without turning my head. I remember a large globe standing on the floor. I was impressed by the broadness of the Pacific Ocean and the great length of our Pacific coast, along which naval bases and other fleet facilities were located, and I came to understand why the fleet commander spent a significant part of his time away from his office. He had a huge household to take care of, and in addition, it was scattered over large distances.

When he finished reading, Fokin leafed through the draft once more, and then, taking a pencil, he reflectively began striking something out at the end of the text. Squinting, I was able to see that he was adjusting

the number of special motor vehicles to be allocated, naturally in the direction of lower numbers. I asked him to keep the quantity the same as before, and explained why. He agreed. I think that he was satisfied by the draft order.

The commander called in fleet chief of staff Rear Admiral N. N. Amelko and handed him the document so that it could be "written up for signature." As I left, I asked him to sign the order as soon as possible. A couple of days later, as I was climbing the porch steps of the headquarters building, I met the commander on his way out. His reply to my greeting was: "I signed the order!"

I think that when it was published, the order had the needed effect. The commander's greater attention to preparations for launching a ballistic missile from a submarine for the first time in this fleet, and the rigid time constraints forced everyone to take all steps to carry out the order, and in short order at that.

Running ahead a little, let me say that even with the forced pace, it was still not until September that the test launchings could be carried out. It would not be difficult to surmise that had it not been for the commander's order, the launch site and the missile impact zone would not have been ready until late fall or early winter, at the start of the period of probable storms and even ice formation in the region of the launch site. And this could have made it impossible to use it in that year.

#### In the Launch Area

The approaching deadline of the tests and the approaching autumn had to be troubling to the fleet command.

In order to check the readiness of the launch site and the missile impact zone, fleet armament and ship repair chief Captain 1st Rank Pavel Petrovich Yermenko organized an inspection trip. His group included Captain 1st Rank V. P. Solovyev, Engineer-Captain 2d Rank N. A. Strakhov and Captain-Lieutenant G. I. Vinokurov from fleet headquarters, Engineer-Senior Lieutenant V. S. Koshelev, and the author.

We took off from Vladivostok in early morning aboard a military LI-2. A few hours later we landed in the vicinity of a certain naval base. After a short stopover we resumed our journey, now aboard a large "hunter." The ship picked up speed and traveled along the shore. The sea was calm, and it was sunny and rather warm. We were all on the top deck, taking in the picturesque shore, covered with a thick, variegated forest. Then the height of the shore began increasing, transforming into steep, rocky mountain spurs. This caused me to wonder how they managed to locate ballistic motion picture camera stations to track the trajectory of the missile under these conditions.

After a little while we saw people and tents to port, located on a narrow beach between the waterline and the almost perpendicular cliffs. We were at the launch site.

The hunter dropped anchor, and the ship's boat—a four-oar skiff—was lowered over the side. P. P. Yermenko went down to it first, and took a seat at the stern

beside the tiller, assuming the duties of senior crewman. I wasn't surprised by this, first because he was the seniormost officer in our party, and second, he even looked like a seaman: strong-bodied, masculine, self-confident, easy-going.

As the skiff rocked with the swells, I accidentally stepped on a thwart, unwittingly violating one of the navy's unwritten laws. This did not go unnoticed, and a remark from the skiff's senior crewman immediately followed. The members of the group took up oars, and on the command "Ship oars!" they began rowing to shore.

Despite the fact that an inspection usually promises nothing good, the "natives" greeted us joyfully under the leadership of the launch site chief, and helped us drag the boat ashore.

All of the heavy all-hands work of unloading the equipment and gear on the unprepared beach, setting up the theodolites and setting up housekeeping had already been finished. No one mentioned the difficulties, but they were obvious. I remember how one officer fell off the precipice and miraculously landed on a ledge, from which he was raised by a length of hemp rope. The story is told with a smile, though understandably, this wasn't at all funny back then. The seamen had made themselves at home, they were ready, and they were waiting for the day in behalf of which they had done all of this extremely hard work.

Immediately after the introductions and the report, indefatigable P. P. Yeremenko began his inspection of the measuring posts. But first we had to get to them. Passing through a narrow strip of dense grass of a species unfamiliar to me and of close to human height, with enormous, bright, odorless flowers, we ascended a narrow, steep trail to a plateau, where we found a green meadow studded with huge pines. The ocean stretched out below us. Structures occupied in the past by border guards stood on the meadow. The central ballistic camera station was located here, on the edge of the meadow. Two others were perched on the mountain slopes like swallow's nests.

The telemetric and radio stations as well as the timing equipment were set up on shore. The latter was to transmit time pulses to all trajectory and telemetric measuring stations upon receiving a signal from the submarine.

The great distance separating the launch site from the test range and the absence of telephonic communication made it difficult to solve any problems that arose, but this was not a hindrance: Everything was in place, housekeeping was set up, and the personnel were ready for action.

In the second half of the day we set off for the missile impact zone. Once again aboard the large "hunter," and then in view of the shallowness of the water we transferred to a tiny vessel—a hydrographic measuring boat. Everything was thought out and clearly organized, wherever we went they were waiting for us, and never was there a minute of delay. Passing through a strait, we entered the missile impact zone. A sandy shore, pines,

dunes, and the sun. The impression was that we were on the seacoast at Riga. We made our way to the buildings accommodating the service and personnel of the impact zone. They were located on the territory of a former prison camp. The well-built log structures, made of thick logs, and especially the former stockade, recalled an ancient monastery.

The impact zone had to satisfy some very different requirements: It had to occupy sufficient area, accounting for the maximum scatter of missile impact points, of course with room to spare, and it had to provide a possibility for officially observing and tying in these points, for which purpose the terrain had to be level and open, and a safe distance from population centers. Fulfillment of all of these conditions made it difficult not only to select the area itself but also to deliver the needed equipment. Senior Lieutenant Eduard Aleksandrovich Denisenko, a very knowledgeable and efficient officer who served as the search party chief at the Northern Test Range, and who was sent here on temporary duty, provided considerable assistance in organizing observation and measurements.

Upon making sure that the missile impact zone was ready for work and after spending the night in the camp, our group departed on its return journey, once again in stages by sea and air, and by evening we arrived in Vladivostok.

The general opinion of the group was that the test range was ready to support the launch tests. One could sense the hand of chief engineer N. A. Strakhov in the work done. He was very well oriented in this situation, and he had it under control.

The voyage undertaken by Yeremenko had positive results. First, following Peter the Great's traditions and slipping on boots, the high-level command was able to correctly assess the situation at remote points in the test area, and their readiness for work, and understand the kind of effort with which all of this was achieved. Second, the personnel of the inspected "garrisons" interpreted the command's visit as a fact confirming the importance of the operation in behalf of which they had worked so selflessly, away from their families and their unit for so long a time. All of this cheered the people up, reduced the sensation of abandonment, and lifted spirits.

#### **'And It Was on the Pacific Ocean That We Ended Our Cruise...'**

It was a time of intense preparations, and of weary anticipation of the main event in behalf of which they were being made. But however slowly the time dragged, through our combined efforts we brought the awaited moment ever-nearer.

The day to set sail for the launch tests was set. After being prepared at the test range the missile was delivered to the pier and loaded into one of the launch tubes of the submarine "B-62". General tests were carried out.

The slow ore carrier "Insara" was the first to shove off. A telemetric station mounted on a motor vehicle chassis

was installed in its spacious hold. Members of the commission and other participants of the tests made themselves comfortable in the cabins. The test command post was set up in the wheelhouse of the "Insara". Our trip to the launch site was going to be much longer than when we went there with P. P. Yeremenko.

Then the submarine "B-62" set off under the escort of a class 56 destroyer. After all of the ships in the area were assembled, the day before the launch tests the launch team and I. V. Popkov transferred from the "Insara" to the submarine. The chairman kept me with him, although by habit I wanted to be aboard the submarine.

Morning of 6 September 1958 came. The area for the prelaunch maneuvers was very inconvenient. The submarine traveled along the high shore, pressing as closely to it as the depth would allow. For this reason the ballistic camera stations were unable to track it in advance, and it did not appear within view of their sighting instruments until just minutes prior to launch, which made the measuring teams somewhat nervous. The "Insar" traveled seaward and ahead of the submarine. The missile was to be launched to port and toward the stern.

The submarine assumed its attack course. The missile was raised out of the launch tube. When the planned launch point was reached, the missile was launched. The picture was an impressive one: The missile left the submarine with a roar and climbed upward on the backdrop of the rocky shore. A radio message indicating that the deviation from the aiming point was within permissible limits was soon transmitted from the missile impact zone.

Now we could confidently assert that the labor of the large collective of people who participated in preparations for and conduct of such an important test for the Pacific Fleet was graced with success. Thanks to all.

A missile submarine, the lead ship of this class in the fleet, had taken its place among warships of the Pacific Fleet, the test range supported the missile launching, and fleet specialists had now been "battle-seasoned," and were ready for independent work. Such was the main result of the activity of all participants of the testing.

Selfless work was done by test range officers Yu. R. Gollandtsev, V. A. Nunikyan, V. V. Gudelkin, V. P. Zakharov, B. R. Feldman, L. K. Sedunov, D. I. Mant, V. I. Shulga, B. P. Grishin, and R. P. Manko in the service area, and Yu. P. Romashkin, N. I. Izhogin, A. A. Yemets, V. A. Bondarev, V. E. Stepanov, G. P. Panarin, and V. A. Zolotarev at the launch site.

Members of the state commission returned to Vladivostok from the launch site area aboard the destroyer. Ivan Vasilyevich and I were up before reveille: The excitement of the previous day hadn't yet passed.

The sea was calm, and the morning was still young. The huge turbines were working noiselessly, and the ship sped lightly over the empty sea, with only the sound of water slapping against the sides breaking the stillness. There was no one on the upper deck. The impression was

that we were completely alone on a boundless ocean. And involuntarily the image of the "Flying Dutchman" came to mind.

And as things turned out, of all of the people who were part of the beginning of this story, only I. V. Popkov and I participated in the last event that ended it—one a representative of the client and the other a representative of the developer.

The difficult journey, which we accomplished so swiftly, was now behind us: from inception of what seemed to be a fantastic idea to solution of real technical problems, from the first test launch of a missile from a terrestrial test bed that simulated rocking of a submarine to missile launchings by attack submarines of two of our fleets. For Ivan Vasilyevich and me, all of this blurred together into one continuous 4-year watch on the solonchak steppes of Kazakhstan, in the Far North, in the Arctic, and on the shore of the Pacific Ocean.

But the events were so bright and captivating, and the meetings with new people were so interesting that they have not faded from our memories. The results of the titanic effort made by the collectives of industrial organizations and by personnel of military units—from the chief designer to the technician and laborer, and from the admiral to the seaman—were impressive.

The production base of a new direction in missile and submarine building was organized and perfected in short time, and the core of our future strategic submarine forces took its place in the formation of the navy's warships.

All of the difficulties of our watch were surmounted and long-forgotten, and the tension of the last months was relieved by the successful test launching from the last missile submarine of the series. We were left with the feeling that we had done our duty, and we developed confidence in our strengths, which would be necessary in new projects. We were conscious of the fact that we were still at the very beginning of the path we had selected, and that all life was still ahead of us. And it seemed as if the racing ship was carrying us into the future. We had an urge to dream. Fantasizing many years into the future, and imagining ourselves in different situations and roles, we had a good laugh over our thoughts.

After years of constant communication with seamen, and having participated with them in the first tests of ballistic missiles, Popkov no longer imagined himself as a navy outsider. His talent as a missile tester and fabulous organizer revealed itself fully in the fleet. He liked the situation in the navy, its harshness and romanticism, and he became infused with respect for seamen and love for the sea—not the sea of beaches, but the sea of cruises. He also learned the value of real friendship, and the sense of closeness that seamen develop. Later on he would have this to say about a certain person he had a liking for: "He can be trusted, he's one you wouldn't mind having on your ship."

The motherland made a high assessment of the heroic labor of the people, and of the significance of the work



they did. The Lenin Prize for 1958 was awarded to a group of its direct and most active participants.

The recipients included N. N. Isanin (from TsKB-16), I. S. Bakhtin (from Plant No 402), I. V. Popkov and P. V. Novozhilov (from OKB-1), V. P. Finogeyev (from NII-885), V. F. Pechurin, V. P. Arefyev and P. M. Zelentsov (from NII-49), and V. P. Makeyev and N. A. Semikhatov (from new organizations that helped create series-manufactured missiles and introduce the weapons into the fleet).

There were no military personnel on this list. It would certainly have included one, had the command chosen one from among the several nominees. Because of its indecisiveness naval deputy commander-in-chief Engineer-Admiral N. V. Isachenkov rejected the slots for the military altogether in favor of industrial representatives. It's a pity, of course, but in the final analysis we hadn't worked for the sake of rewards, and no one ever promised them to us. Moreover the recipients were comrades who were well known to us, and were worthy of this high award. No undeserving people were included among them just to satisfy political considerations.

I. V. Popkov wrote the following to me in a letter dated 22 April 1959: "The prize about to be received by those 10 persons selected from a large number of people represents your labor and that of many of our comrades." This was the assessment of a modest and honest person who understood the kind of effort these "many" had to invest into the work they did.

### The Secret of an Underwater Launch Exposed

My reconstruction of the history of creation of missile weapons for strategic submarines would be incomplete without also recalling and relating some events associated with the first underwater launch the navy tried to forget. Our lead missile submarine "B-67" and the first naval ballistic missile, the R-11FM, have a direct relationship to them. These events are also worthy of illumination as yet another clear example of the heroism of the pioneers. But let's take things in order.

Despite the fact that work had already begun on the "Volna" project, which foresaw launching a missile out of a launch tube from a surfaced submarine, naval seamen wouldn't let go of the idea of an underwater launch. Remaining a proponent of this idea, P. N. Maruta, introduced to the reader earlier, continued to insist on the need for studying this means of launching a missile. He was able to persuade the deputy chief of the NII-88, who agreed to assume scientific leadership over the project. Upon subsequently attaining support from the leadership of the shipbuilding and defense sectors of industry—M. V. Yegorov and K. N. Rudnev, and from a special committee of the Council of Ministers (subsequently named the Council of Ministers Presidium for Military-Industrial Issues)—G. N. Pashkov, Maruta drafted a decree and submitted it to the Council of Ministers. On 3 February 1955 the decree was signed by N. A. Bulganin. According to this document the work was assigned to the OKB-10 of NII-88 (chief designer Ye.

V. Charnko), SKB-626 (chief designer N. A. Semikhatov) and TsKB-16 (chief designer N. N. Isanin).

Yevgeniy Vladimirovich Charnko, who was by now a well known and honored artillery system designer and a four-time recipient of the Stalin (now the State) Prize, accepted this enterprise, which was new to him, trusting in the creative strengths of his collective, which demonstrated its ability to successfully solve complex technical problems in record time.

The real difficulties that arose on the OKB-10's path had to do with the absence of experience in missile building, an insufficient understanding of the nature of hydrodynamic processes associated with an underwater launch, and marine conditions of weapon use that were totally new to it, not to mention the unusual features of navy life in general. Though I would have to admit that these circumstances could also have played a positive role in the sense of arriving at nonstandard solutions. The main group from the OKB-10 included A. Charnko, V. Isayev, A. Loktev, I. Avrugin and others.

Appointment of Engineer-Captain-Lieutenant V. K. Svislunov as the lead specialist for the project from the navy turned out to be especially fortunate. He did a great deal to help Charnko learn the unique features of submarine missiles, and to achieve close coordination with fleet representatives. Naval participants of the project included V. A. Yemelyanov, K. K. Ilinskiy, A. G. Melnik, B. F. Vasilyev, V. V. Bashenkov and N. N. Grigoryev.

Having acquainted himself with available materials from theoretical research and experiments conducted in the navy's rocket research institute, Charnko made the decision to prepare immediately for so-called throw [broskovyye] tests to perfect the launching procedure using full-scale models of the R-11FM missile.

All of the work as a whole was to be carried out in three phases: throw tests from a motionless submerged test bed, continuation of these tests from a moving experimental submarine, and finally, aimed launching of the missiles at maximum range from a moving submarine. The goals and objectives of the tests were stated definitely, but several questions did arise right away: What sort of launch pad is to be used, where should the launching be carried out, and what should be done to improve the missile and the launcher?

The collective of the TsKB-16 once again took an active part in the work. N. N. Isanin, N. N. Zvelt, V. V. Zenkevich, V. M. Langovoy, I. N. Savinova, Ye. I. Kuchin, V. I. Yefimov, V. M. Volkov and other associates participated directly in the testing.

A special submersible test bed was designed and built under the guidance of chief designer Ya. Ye. Yevgrafov. It was based on a full-scale launch tube 12 meters high and 2 meters in diameter, which was set up on a pontoon. The test bed was designed to be submerged to 20 meters. When the time came for tests, it was first lowered to "trimming-down" depth by filling the ballast tanks, and then, after all people were clear of it, it was pulled down to launching depth by a winch and cable

connected to the test bed and passing through a pulley block secured to a concrete block on the sea bottom beneath the test bed. The preparations and the launching were controlled by cables laid on the bottom from the test bed to the shore.

Two types of missile mock-ups were designed for the tests: the S 4.1 with a powder rocket engine, and S 4.5 with a liquid-propellant engine.

The onboard and ship (test bed) control system was developed by the SKB-626. V. A. Vnitskiy, I. S. Igdalova, I. I. Velichko and other associates of this design office also participated in the tests.

Under the chairmanship of Engineer-Colonel M. F. Vasilyev the reconnaissance commission selected the area for the tests—a certain bay on the Black Sea coast.

By late 1956 everything was ready for the tests, and the first launching of an S 4.1 missile mock-up from beneath the water was carried out on 23 December. The three subsequent launchings were in March-April 1957.

Concurrently with creating the submersible test bed, the "S-229", a class 613 midsize submarine, was planned and refitted as a class V-613 submarine. Two missile launch tubes were suspended on the sides of the submarine in its mid-section. A possibility for launching missile mock-ups from a depth of 15-20 meters while the submarine was traveling at 3-4 knots was foreseen.

The second phase of the tests, which involved the class V-613 submarine, began soon after the program of launching S 4.1 mock-ups from the submersible test bed were completed. Three launchings of an S 4.1 mock-up were carried out from the submarine in June 1957. A break in the testing was scheduled until February of the following year in order to permit manufacture and delivery of the missile mock-up with a liquid-propellant rocket engine—the S 4.5. Without waiting for the entire program of throw tests to end, the commission of the Council of Ministers Presidium decided to refit the submarine "B-67" as a class PV-611 submarine (the letter "P" meant "underwater") on the basis of the results of launching the S 4.1 mock-up from the test bed and the submarine.

The throw tests were resumed in February 1958, and by mid-April S 4.5 mock-ups were launched seven times—four from the test bed and three from the class V-613 submarine.

I would like to voice my opinion regarding the throw tests. In the first half of the 1970s I had the opportunity to serve as technical supervisor of such tests on a new missile that was being designed at that time. I was able to acquaint myself fully with the entire procedure of these tests from both the technical and organizational aspect, and therefore I can assert that the tests conducted by Ye. V. Charnko, in which 14 launchings were carried out in 15 months, proceeded at a good pace. Successful fulfillment of the entire program of tests never conducted before in relatively short time was the result not only of

their efficient organization under the leadership of Captain 1st Rank G. F. Makarenkov, commission chairman and submarine forces chief of staff of the Black Sea Fleet, and technical supervisor Ye. V. Charnko, but also the efficiency of industrial enterprises, which supported on-time deliveries of all objects and resources for the testing, and the necessary changes based on the results of ongoing launchings.

The third phase of the tests began in late summer 1959. By this time the first naval ballistic missile, the R-11FM, had been rebuilt for underwater launching, and it was code-named the S 4.7, while the submarine "B-67" was refitted as a class PV-611 submarine.

Our flagship of strategic missile submarines continued to be the leader in testing naval missiles. It was now credited with as many as four trials following the flight tests in 1955, the transportation tests in 1956, and the blast resistance tests in 1957.

The state commission that was to carry out the forthcoming tests was headed by Captain 1st Rank Aleksandr Naumovich Kirtok. By this time there had been a change of command aboard the submarine "B-67". Captain 2d Rank D. D. Yan'kin replaced I. I. Gulyayev as the submarine commander. Executive officer Captain 3d Rank V. K. Korobov, who had participated in the tests on the missile system, was appointed commander of the first submarine armed with a cruise missile, the "S-146"; gunnery department commander S. F. Bondin was sent to the Naval Academy for training.

The first missile launching from beneath the water was unsuccessful—I would even say dramatic, and it was only by pure chance that it did not end in disaster. Back then, I knew that this happened, but as for the details, they were communicated to me by the direct participants of this launching—V. K. Svistunov and V. I. Lyamichev, who replaced me at the test range in early 1958 and carried out the duties of launch supervisor in this project. The launch team included officers Ye. A. Zaytsev, V. Ye. Trinko, Ye. F. Onanko and Yu. N. Kaskov from the test range.

The events unfolded as follows. All of the standard operations of preparing for and conducting the launching were carried out during submerged approach to the launch point. A noise was heard in the launch tube (before this, no one was able to hear the sounds made by the missile as it took off because in the throw tests, there was no one at the test bed), and according to the lights on the signal panel it appeared that the missile had taken off. They shut the launch tube lid. The crew rejoiced. The excitement was understandable: This was the first time a missile was launched from a submerged submarine.

In the meantime naval and industrial representatives aboard the experimental ship "Aeronavi" waited expectantly for the missile to break the surface. It did not appear. And when the submarine surfaced, their anticipation gave way to bewilderment.

Instead of the wished-for message from the "Aeronavt" that the missile reached the impact zone, the code transmitted to the submarine read: "Launching not observed."

Time passed while the perplexed missilemen speculated over the code, feeling in general that this code was some sort of mistake. The "Aeronavt" approached and tied up to the submarine's side. Its bridge was occupied by admirals V. N. Ivanov, P. G. Kotov, L. G. Osipov and V. P. Tsvetko, and executives from industrial enterprises. They put their heads together to decide what to do. They decided to open the lid and inspect the launch tube.

Commission chairman A. N. Kirtok, submarine commander D. D. Yankin and chief designer Ye. V. Charnko were present on the submarine's bridge beneath the canopy. V. I. Lyamichev set off for the launch tube for the inspection, and he was followed topside by the executive officer and a signalman. Before the lid of the launch tube was completely opened Lyamichev saw inside it the missile that should have flown out around an hour ago. Messages were exchanged between the bridges regarding what to do next. However, the discussion didn't develop very far because at this moment an unsanctioned (missilemen do have such a term) launching occurred. To be more accurate, sanctioned but not carried out on time. The missile flew out of the launch tube with a roar before the eyes of the stunned onlookers, rushed upward, and disappeared from view. The direction of its flight was unknown, because the submarine was adrift, and its orientation with respect to course was not being monitored.

Everything happened so quickly and it was so crowded on the bridge that no one had time to take cover. The participants remember bits and pieces of the "emergency evacuation." In a single rush, the command group beneath the canopy lunged for the upper conning tower rescue hatch. But because there was no time for an orderly withdrawal, and in addition the chief executive had leaped down from above and got stuck upside-down, no one was able to move any farther than the hatch coaming. In the rush, some even received light injuries.

Lyamichev, who was exchanging messages with P. G. Kotov before the missile took off, and who decided that continuing the dialogue from ship's side to ship's side was inconvenient, opted to transfer to the "Aeronavt". He had just straddled the railing of the conning tower with the intention of descending the ladder when the missile's engine started up. Sensing the uncomfortably high heat, Vasilii Ivanovich had no choice but to jump down onto the deck of the "Aeronavt". When he ascended to the bridge, he found everyone lying there. No, no one had been killed. Each had simply frozen in the position he was able to take for the sake of his own safety, not believing yet that it was all over.

On learning that missile was still in the launch tube, Lieutenant-Colonel Nikolay Ivanovich Zakharov, present aboard the submarine as the senior military representative from N. A. Semikhatov's design office, decided that it would be wiser to transfer to the "Aeronavt" and wait there while things were sorted out. It was

just as he was crossing over the gangplank that had been laid between the ships that the missile took off. Zakharov lost his balance and fell into the water, now finding himself not in a potential but in a real dangerous situation, risking being crushed. The seamen pulled him up, and in the meantime the missile flew away.

Only the signalman remained at his duty station. All he had time to do was crawl beneath the open launch tube lid on his side and cover his face with his flags. A succession of lucky breaks made the safe outcome of this extraordinary occurrence possible. The engine of the faulty missile started up when the launch tube lid was open, and this could have happened with equal probability at any time with the lid shut, and with the submarine both submerged and on the surface.

No one was injured by the flame and gases emerging from the nozzle of the rocket engine. I don't think that the slight "industrial" injuries and mild fright count. Nor was anyone noted to have suffered any psychological trauma then or thereafter.

The missile was tilted slightly toward the "Aeronavt" as it left the launch tube, owing to which a dead zone formed around its bridge, out of reach of the gas jet. Had the vessel been tilted in the opposite direction, the consequences could have been unpleasant.

The missile didn't fall back on the submarine or the "Aeronavt", which could have happened because its flight was uncontrolled.

Despite the arbitrary position of the submarine and the chance horizontal orientation of the missile prior to launching, it flew, we found out later on, in the direction of the sparsely populated shore.

And one last lucky break. Having flown several dozen kilometers, the missile impacted not far from a barn where luckily no one was present at the moment. Seamen who set off a little later in search of the fallen missile found it with the help of local inhabitants. Because this was supposed to be a secret project, no mention of the missile was made, and the locals were asked if they had seen a plane come down, to which the simple but civilized "aborigines" replied: "Nope, didn't see a plane, but your missile's back there, next to the barn!"

It's perhaps typical that people who had escaped misfortune subsequently recall the event in question with humor. As for me, I can still clearly picture the situation—a tongue of flame billowing from the missile as it took off, not more than half a meter from the side of the conning tower enclosure—and I can't write about it matter-of-factly.

What happened was simply a miracle—there were no casualties. But the tests were stopped, and for a long time at that. They did not resume until a year later. During this time one more check launching was carried out from the test bed. This lengthy pause was explained not only and not so much by the need for clarifying and correcting the causes of the event, as by the psychological factor: Everyone had to gather his wits after the shock.



On 14 August 1960 the submarine, now under the command of V. K. Korobov, a veteran of the tests, set off for a second launch test. Once again a mishap. The missile's airframe was damaged once again during prelaunch preparations as the launch tube was being filled with water. This time the damage occurred to its nose section. The umbilical plug connectors separated again as a result, and as in the previous accident, the missile remained in the launch tube with its fuel tanks pressurized. In order to preclude its spontaneous launching, the pressure had to be bled from the tanks, but this could be done only by restoring the missile's electrical connection with shipboard control system apparatus. For this, the plug in the launch tube had to be reconnected. But how was this to be done, and by whom? No one had the right to order someone to carry out this nonstandard and dangerous operation.

When V. K. Korobov appealed to personnel of the gunnery department, all expressed a readiness to carry out the operation. Volunteers were also found among officers of the launch team—N. A. Druin and Ye. F. Onanko. After the launch tube was drained, the former, who was slimmer and more agile, crawled inside the launch tube beneath the missile through the neck in the lower part of the launch tube. The other remained in the compartment, acting as his safety. The plug was reconnected.

Owing to the bravery of the valiant young officers, who completed a life-threatening operation that had not been foreseen by any of the instructions, the missile was rendered safe, and the submarine returned to base. It was only because the missile was left intact that the cause of the two accidental launchings could be revealed. Unfortunately the heroism of these people wasn't marked in any fashion, and generally forgotten.

The third test launch occurred a month later, on 10 September 1960. This time the launch proceeded normally, and the missile flew the prescribed distance and reached the impact zone.

The state commission confirmed the possibility of launching a missile from beneath the water on the basis of the results of the throw tests and successful launching of the missile from the submarine.

It no longer made any sense to begin series production of underwater-launched missiles on the basis of the R-11FM missile because the next surface-launched missile, which had a range several times greater, had been adopted by this time. Moreover an objective of this kind was never posed. The importance of the work done under the supervision of chief designer Y. V. Charnko to the development of sea-launched missile building lay chiefly in the fact that it broke down the barrier of doubts and skepticism in relation to this means of launching. The extremely difficult road of learning about the conditions typical of such launching had been traveled, and design concepts making it possible to launch missiles from beneath the water were found. There were no mysteries about an underwater launch. All of this was doubtlessly accounted for and utilized in the design of the first live missile to be launched from beneath the water.

Also important to history is the fact that our first-born—the R-11FM missile and the submarine "B-67"—once again participated in pilot functions in the laying of the new course.

Ending this chapter, I have to say that the doubts that existed then regarding an underwater launch, which delayed the efforts to perfect it, lengthened the time it took to adopt underwater-launched ballistic missiles for submarines.

And so it happened that after being first in the world to launch a missile from a submarine, and forestalling the USA in this, we subsequently fell noticeably behind, and many years were needed to catch up. Evidently this is the path of development that is typical of us: Having proven our ability to be first, we relax, and then only after persuading ourselves that we have been overtaken, do we begin making up for lost time, sparing neither material resources nor manpower.

### The Last Meetings

Beginning in the early 1960s the collective of the OKB-1 no longer took a direct part in naval projects. But my friendship with I. V. Popkov continued, and whenever I visited Moscow, I always looked him up in Podlipki. When possible and convenient, I also visited S. P. Korolev. My meetings with these people boosted my strength, and in a sense I was recharged by their energy.

In spring 1963 I returned from Kamchatka. By this time the transportation tests on R-13 missiles with a submarine of the next class, 629, had been concluded. The goal of these tests, at which I served as assistant chairman of the state commission, was to determine the possibility for increasing the time of storage of missiles in launch tubes. The tests were conducted once again under extreme conditions typical of tropical latitudes in order to make sure that the missiles would be combat ready in the presence of high air temperature and humidity in the launch tubes.

The test results were positive, and the commission recommended doubling the permissible time of storage of missiles in launch tubes. Such that when I met in Podlipki with people who had an interest in everything associated with the enterprise they had begun in the navy, I had something to share with them.

Popkov and I decided to visit Sergey Pavlovich. We showed up at the OKB-1 before work, knowing that he always came early. We met him in the hallway by the visitors' waiting room. "So where did you blow in from?", he asked the moment he saw me, and without waiting for a reply, he invited us into his office.

Ivan Vasilyevich always came to work alert and neat. This time he was wearing a snow-white shirt and a dark blue suit, he was clean-shaven, ruddy-cheeked, and his hair was neatly combed. He was just as neat, efficient and composed in his work.

S. P. Korolev treated I. V. Popkov as a strict teacher would a talented, highly promising student, helping him in his development by giving him especially important,

difficult and urgent assignments. It always seemed to me that when they were together, in Ivan Vasilyevich, Sergey Pavlovich saw himself in his youth. In this meeting as well, eyeing the person who was now his testing assistant and parading his approval, S. P. Korolev turned to me and said: "Look how our Vanyusha has turned out!" The Chief, I surmised from this, wanted to share his opinion of his assistant: Not only does he cut a good figure at the test range or at sea aboard a submarine, where we know of his capabilities, but also he can appear as he did here, so elegant and dignified.

Sergey Pavlovich had to be pleased by the fact that the person upon whom he relied was always in uniform, ready for action. That was the way Ivan Vasilyevich was in life. One could always sense a kind of joyful burning passion within him. I remember him joking once: "To burn, to catch fire, but not to burn up!"

During our short discussion Korolev asked about the progress in introducing the new missile technology to the ships, and expressed satisfaction that the idea of long-term storage missiles was developing further.

Our conversation was continually interrupted by the ringing telephone. It was evident that we weren't the only ones who knew that he came to work before everyone else did. One call was from an associate asking his help in placing her son in the Nakhimov School, another was a request to expedite resolution of a housing matter, and someone else required treatment at a sanatorium. The Chief answered everyone quite graciously, essentially trying to help. Some time earlier, by the way, he provided assistance in placing Ivan Vasilyevich's mother for treatment. Korolev was a cordial person, and his heart was not hardened by the everyday adversities that fell to his lot. Toward the end of our interview the discussion turned to my desire to transfer to the OKB-1—something I had already communicated to Ivan Vasilyevich earlier. Sergey Pavlovich gave his approval of this plan, and attempted to hook up with the naval commander-in-chief on the spot, but he wasn't in. Rising from his desk, Sergey Pavlovich promised in parting: "We'll get you transferred over to us, and I'll get you an apartment!" On my part, rather than thanking him, and simply trying to make the conditions of my transfer easier, I thoughtlessly blurted out that I had an apartment in Leningrad, which I would exchange for one here. I think Sergey Pavlovich was offended. He had offered me a gift, and from all appearances I was refusing it.

There is a mention in my notebooks of a telephone conversation I had with Korolev from Leningrad on 27 August 1964. When I asked a very courteous secretary to connect me to him, Sergey Pavlovich picked up the phone very quickly. I wanted to find out if he had been able to talk with the naval command regarding my transfer. Not yet, it turned out. Then I asked him:

"Have you any plans to meet with the naval commander-in-chief?"

"O.K., I'll try!" Sergey Pavlovich replied.

Such was our conversation, brief but very typical of Korolev. Despite being enormously busy with major projects of truly universal importance, generally speaking he did not forget about things that were totally unimportant to him personally, if they concerned other people. Sergey Pavlovich always had time for people and their concerns.

I realized that the matter of my transfer was not a simple one, but there was hope. However, subsequent events began unraveling all of the plans.

In the evening of 28 January 1965 I received a telegram from Ivan Vasilyevich's wife, Lyudmila Gennadyevna bearing the sad news that Ivan Vasilyevich had been tragically killed at the test range. Next day I left for Moscow.

I. V. Popkov's funeral was held on 31 January. The whole city was in attendance. A sea of people flowed toward the Palace of Culture, where the casket containing the decedent's body was placed. Korolev, who was ill at the time, got up from his sick bed and came to the funeral. He was joined by V. P. Mishin, S. I. Okhapkin, and other friends from the leadership of the OKB-1 and the GKOT.

Standing at the head of the casket in an honor guard, the chief designer bade farewell to one of his best students on his final journey, a person of like mind and so necessary an assistant, who absurdly departed from this life at an age of 35 years, at the dawn of his life and creativity.

The grief felt by Ivan Vasilyevich's family—his wife and still very young children, two boys and a girl, and his parents, brothers and sisters—was immeasurable. I had lost a friend and a wise adviser. A person so greatly needed by many people, who loved people and always tried to see something positive in them, had departed from this life. He was the one who said: "We know that there are bad things in people, but let's try to find the good in them, life would be so much nicer that way!" Witnesses said that even after receiving his mortal injury, he rushed to the aid of his comrades, who fortunately escaped with nothing more than bruises. In this noble rush lay the entire essence of Ivan Popkov.

In summer 1965, when I was once again passing through Moscow, I looked up Sergey Pavlovich. I reiterated my intention to work under his charge, although without Ivan Vasilyevich, everything was to be much more difficult. The Chief gloomily and bitterly talked about the circumstances of Popkov's death. I concluded from my short talk with Sergey Pavlovich that the consent he had given earlier was still in force, and I had but to wait for the decision.

Then on 15 January 1966, like thunder out of a clear blue sky, news was flashed of the death of twice-awarded Hero of Socialist Labor, Lenin Prize laureate, Academician S. P. Korolev. On 16 January I paid my last respects as I passed his casket in the Hall of Columns of the Palace of Unions. There was much that was mysterious in his early demise. Here are some extracts on this subject from Colonel-General N. P. Kamanin's diary, published in the February 1991, No 7 issue of the journal OGONEK:

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9 January (1966)

*"A few days ago Korolev was admitted to the hospital for a 2-3 week stay.... According to the initial information the operation was not to be a serious one, though rather unpleasant."*

17 January

*"Petrovskiy, the minister of public health, himself operated on Korolev. Sergey Pavlovich came to the hospital on his own two feet, as they say, and the doctors assured him that the operation would last just a few minutes, while actually it took over 5 hours. His weak heart could not withstand such a load, and paralysis set in."*

19 January

*"Korolev has taken his place in the Kremlin Wall beside S. V. Kurashov (the USSR Minister of Health). I was taken aback by such close placement of the two—it was an additional reminder of the great blame borne by our medicine for Sergey Pavlovich's premature death."*

I also heard that Sergey Pavlovich went to the hospital in a fit of temper: "If they don't want to work with me, I might as well tend to my health." As it turns out, Korolev's fame was disturbing to many who felt that they were his equals, and could work just as well as he. Capitalizing on their closeness to N. S. Khrushchev, some of them managed to win orders for development of spacecraft launch vehicles in parallel with Korolev, and all of the foundation work, all of the experience, and all of the documents of the OKB-1 were transferred to them. The military tried to distance themselves from Korolev and prepare the cosmonauts for the flights and man the crews on their own. All of this had to trouble Sergey Pavlovich: People were beginning to dismantle, restructure and pull apart the enterprise of his entire lifetime. This was the kind of situation that evolved, one that couldn't allow normal work. We can learn more about it from notes written by that same N. P. Kamanin in his diary, and from the memoirs of contemporaries in the book "Academician S. P. Korolev. The Scientist. The Engineer. The Man."

After Korolev's death, Kamanin wrote: "S. P. Korolev was the principal author and organizer of all of our successes in space; at his wake, however, all who spoke emphasized Korolev's role as a great scientist, saying nothing about his being the leader of space research, and they said that our country had many people like Korolev. This was not true.... He was the Chief Designer of spacecraft, and not only by position but also in essence. I have always felt Korolev's talent to be priceless. I'm also aware of the failings in his character, but they cannot overshadow the grandeur of the figure of our Chief. His name must stand above the names of all of our cosmonauts. I am deeply certain that this is how things will be."

And so, what happened later? A series of disasters: 25 April 1967—V. M. Komarov's death, 27 March 1968—the death of Yu. A. Gagarin and V. S. Seregin, 30 June 1971—the death of G. T. Dobrovolskiy, V. N. Volkov

and V. I. Patsayev. Were these unforeseeable accidents? Perhaps! But the probability of their occurrence would have been lower under S. P. Korolev, under his ever-watchful eye. There can be no doubt of that! After all, while from 1961 to 1965 inclusively, at the dawn of man's conquest of space, there wasn't a single accident involving the death of cosmonauts in flight, in the five subsequent years there were three accidents with six victims. Such are the tragic statistics.

Had I known in 1965 how difficult things were for Sergey Pavlovich, and about the troubles with which he was burdened, and the tension under which he lived, I never would have made my request of him. But I didn't learn about any of this until many years later, and now I'm amazed that he even received me at all. This is one more indication of his respect for people, of his faithfulness to his word.

My last, totally unexpected meeting with Sergey Pavlovich occurred on 10 January 1992. A new documentary film titled "Top Secret. Unknown Pages From the Life of Sergey Pavlovich Korolev," dedicated to his 85th birthday, was being shown that day. The film was noteworthy in that it showed for the first time some film clips associated with the years of this person's persecution, and in that it restored the truth about his family life. Work at the test range and recollections of people who worked with him were shown. Clips with a naval theme were shown for the first time among segments showing the principal work led by chief designer S. P. Korolev: the submarine as it set out to sea, personnel responding to battle stations, the missile raised from the launch tube a minute prior to launching, and finally, the launching itself. I relived what I had experienced then. You see, as participants of the testing we were sitting at consoles in the submarine's missile compartment, fulfilling commands transmitted by the Chief from the control room. The naval activity in S. P. Korolev's creative biography was finally confirmed visually.

The film was very truthful and sympathetic to him. I wish to thank its creators, and primarily the script co-author and director A. Berlin. My hopes rose that events associated with creation of sea-launched ballistic missiles and the birth of missile submarines would finally become known to our people, and the "blank" pages of this glorious history would be written.

#### Thirty-Five Years Later

That's how long we had to wait before we could celebrate creation of the first strategic missile submarine—the class V-611 submarine "B-67", and its missile system equipped with the first sea-launched ballistic missile—the R-11FM.

This was also probably to be the last meeting of the veterans who participated in the historic events of those distant years: After all, half of a human lifetime and the time of almost an entire life of labor and creativity had passed since then. It took so long for us to get together that unfortunately, many were unable to survive to this day.



The patriarchs of Soviet missile submarine building departed at different times: the fathers of our enterprise—chief designers S. P. Korolev and N. N. Isanin, and their faithful associates N. A. Pilyugin, A. M. Isayev, V. F. Pechurin and E. I. Eller. N. A. Sulimovskiy, who gave ideological inspiration to the new weapon's creation, and A. T. Melnikov, N. P. Prokopenko and B. V. Barsov, who worked with him in those times, have been dead a long time. Courageous testers L. A. Voskresenskiy, V. I. Voznyuk, I. A. Zolotnikov and I. A. Khvorostyanov are no longer with us. Never again will we see the stormy shipbuilder Ye. P. Yegorov. General designer V. P. Makeyev, who was successor to Korolev's naval project, died. And this mournful list was begun by one of the youngest, assistant chief designer I. V. Popkov.

Bitter was the minute of silence in memory of all of those outstanding people, who left a bright imprint in the history of the navy, and who did so much to strengthen its might.

I. I. Gulyayev and I had suggested the idea of having a meeting of the veterans for a long time, but given how quickly our life marches on, we couldn't focus on carrying it out. But one day, realizing that in a little more time there might be no one left for such a meeting, we decided to go into action.

We were aided in this by naval commander-in-chief Fleet Admiral V. N. Chernavin, with whom I. I. Gulyayev had served in a certain submarine formation in the Northern Fleet. The commander-in-chief gave his approval to our proposal to conduct a conference dedicated to the first launching of a ballistic missile from a submarine, an event marking the birth of the navy's strategic submarine forces.

The goal of the conference was to restore the forgotten pages of the navy's history concerned with the initial phase of the scientific and technical revolution that occurred in the navy in the 1950s, to assess the significance of the pioneer work done to arm submarines with ballistic missiles, to remember the people, the creators of the heroic enterprises, and to finally identify them publicly.

Held in St. Petersburg, the conference was sponsored by the Malakhit marine machine building office, the leadership of which graciously agreed to assist us in this. V. B. Belomorets, G. D. Morozkin and V. F. Bildin took an active part in its preparation and organization. Gulyayev and I were left with organizing the program of this function.

We impatiently awaited the arrival of the veterans and conference guests. Most of the people who convened were from Leningrad. Several individuals came from Moscow. Unfortunately there was no one from the Energiya Scientific-Production Association, organized out of Korolev's OKB-1, even though they were invited. In any case Academician V. P. Mishin or A. P. Abramov could have come and shared their recollections of designing the R-11 long-term storage missile, its sea-launched modification—the

R-11FM, and the launcher that supported the launching of this missile from a submarine.

The first of the Muskovites to respond was Vladilen Petrovich Finogeyev. He came with his wife, which was another indication of the good memories he had of the past, ones he wanted to share with a person close to him.

Tall, stately Vyacheslav Pavlovich Arefyev, who seemed ageless, appeared with his friends Yuriy Alekseyevich Shcherbakov and Viktor Yakovlevich Sokolov.

Finogeyev and Arefyev had created the missile system's control system, and both are Heroes of Socialist Labor, recipients of the Lenin Prize and doctors of technical sciences.

The command of the unaging crew of the legendary submarine "B-67" came together: the "three captains"—the commanders of the ship at different times—Fedor Ivanovich Kozlov (until 1955), Ivan Ivanovich Gulyayev (until 1959) and Vadim Konstantinovich Korobov (since 1959), and the commanders of this submarine's departments—S. F. Bondin (gunnery department), V. I. Sidorin (underwater weapons department) and A. F. Agapov (engineering department).

Gulyayev and Korobov were awarded the Hero of the Soviet Union title. Korobov finished his long and faultless career in the Northern Fleet as fleet chief of staff and a three-star admiral. The entire group of submariners was headed by the commander of the brigade to which this submarine belonged—Rear Admiral Vladimir Petrovich Tsvetko, who was just as spirited as his team.

The first testers from the naval weapons test range came—F. P. Sorokin, V. P. Yefremov, Ye. A. Bykov, A. I. Suslin and B. A. Zolotyakov.

V. K. Svistunov and V. I. Lyamichev, the two "Last Mohicans" who took part in the first tests conducted with the purpose of perfecting underwater launching of the R-11FM missile, appeared. The veterans included shipbuilders and designers of the missile system's carrier and the ship systems: I. N. Savinova, S. R. Dementyev, V. I. Nekrasov, B. Ye. Pukshanskiy, D. F. Osharov, V. M. Langovoy and others.

Naval seamen from the Naval Scientific Research Institute who were among the pioneers took part in the conference: V. N. Sheremetyev, A. G. Vyzolmirskiy, A. A. Zuykov, D. P. Tkachenko, A. S. Avdonin, V. V. Bashenkov and B. F. Vasilyev.

Despite his ill health, Pavel Nikitich Maruta, who was N. A. Sulimovskiy's faithful and steadfast collaborator, took part in preparing the materials of the conference. Unfortunately his illness prevented him from attending the conference.

Thrice-awarded Hero of Socialist Labor Academician A. P. Aleksandrov and twice-awarded Hero of Socialist Labor Academician S. N. Kovalev, and other merited representatives of defense industry and the navy were present at the conference.

Among those invited, it was pleasant to see young specialists who had not lost their interest in the work of the senior generation of submarine designers.

It was a joyful day for the veterans when they convened and relived the romanticism and excitement of the past unforgettable years, felt young and needed, reexperienced their part in events of great state importance, and were able to persuade themselves that their labor was not in vain. This was also an opportunity for them to meet with those who continued the journey on the course they plotted.

The speeches given by veterans V. P. Finogeyev, V. P. Arefyev, V. I. Sofronov, B. F. Vasilyev, F. I. Kozlov, I. I. Gulyayev and many others were detailed and clear, and there memories were unfaded by time, which was an indication of the depth of the experience.

They described the conditions in which they worked, the trust of their supervisors, the mutual understanding between collectives of all organizations from both industry and the navy, and the naval seamen who in short time prepared themselves for the tests and supported them.

The almost fantastic uniqueness and novelty of the work made it captivatingly interesting, and the tight schedule imposed upon the people required them to make sacrifices and contribute their full effort. The activity of the two chief executives of the work, the remarkable duo of great Chiefs—S. P. Korolev and N. N. Isanin—was an inspiring example to all participants. It was to a significant extent owing to them that the swift pace was maintained, and that astounding results that opened the way for a new direction in arming the fleet and the country as a whole were attained in record time. After all, just a year and a half after the decree was published, the first missile submarine was designed and prepared for launching ballistic missiles; in the course of 1 year, from May to October, two phases of flight tests were carried out, and 20 missile launchings were conducted from a terrestrial test bed and from a ship.

The ingredients making such success possible included the daring and correctness of the decisions, the high dependability of the equipment, the clear organization of all work, the high professionalism, initiative, good intentions, and interaction of all participants of the work, selflessness in work, and simplicity in personal things.

The results made it possible to continue work far beyond what the decree called for, to test the ship and weapons under real conditions (transportation tests and blast resistance tests) in a little less than 3 years, and to create a nucleus of strategic submarines in the Northern and Pacific fleets.

The head industrial organizations established in those years confidently continued their activity. Thus, under the leadership of N. N. Isanin, in subsequent years the TsKB-16 developed another six classes of missile submarines, used to test four missile systems, and it conducted the first experimental launching of a missile from beneath the water, and unique tests on a ballistic missile intended against naval targets.

Later on the organization that took over Korolev's naval project developed another five missile systems on the basis of the experience of creating the R-11FM missile. Such was the development enjoyed by the pioneer work carried out under the leadership of S. P. Korolev and N. N. Isanin 30 years previously.

I think that the significance of the work done also lies in the fact that to its participants, it was a major learning experience in terms of their professions and their life. They had someone to use as role models, and I don't think I would be wrong in suggesting that many subsequently measured their own thoughts and actions up against teachers such as S. P. Korolev, N. N. Isanin, N. A. Pilyugin, A. M. Isayev, Ye. P. Yegorov, V. F. Pechurin, N. A. Sulimovskiy, L. A. Korshunov, V. I. Voznyuk and I. A. Khvorostjanov. The veterans lived a long life, took part in many projects, experienced different situations, and had the possibility to compare and properly evaluate these leaders. It's no accident that a number of participants of the anniversary celebrations subsequently developed into prominent industrial executives and military commanders.

The recognition given in the speech by the general designer of the gigantic "Tayfun" class strategic missile submarines to the fact that the class V-611 submarine, from which occurred the world's first launching of the sea-launched R-11FM missile, was their forefather was an expression of gratefulness to the veterans and an assessment of the importance of the work they did.

In his greeting to the conference participants naval commander-in-chief Fleet Admiral V. N. Chernavin made note of the tremendous role played in the birth of the navy's strategic submarine forces by the creators of the first missile submarine, the "B-67".

A congratulatory poem recited to the conference participants by Sergey Pavlovich's daughter—Natalya Sergeyevna Koroleva, a doctor of medical sciences and a professor—was a pleasant surprise.

I would like to conclude this chapter and the essay as a whole with a dedication given by Engineer-Rear Admiral V. I. Lyamichev, the former deputy chief of the State Central Naval Weapons Test Range (such was the name given later on to the naval weapons test range).

**TO THE CREATORS OF MISSILE SUBMARINES**

We convened to remember the year  
When the launching of missiles into "Ponoy's  
Quadrant"  
Began the era of missile submarines  
In the history of the Northern Fleet.

And while the burden of creation was heavy,  
And the journey was long,  
The Union multiplied its might with ships,  
From the first "AV's" to the mighty "Sharks".

We were led to success not only by orders  
And by the designs of daring directives,  
But also by all patriots of Soviet mandates,  
By generations faithful to their fatherland.

We gave over our minds and our strength  
To the Soviet Navy forever.  
Let there be unfading glory  
For the navy's creators.

Glory to all who completed the journey  
Of unity of deeds and of words,  
Glory to the fathers of our deeds:  
Both Isanin and Korolev.



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